NOTE

Changes in Gliadin Proteins During Cookie Making[1]

Y. POMERANZ,[2,3] G. L. LOOKHART,[2] G. L. RUBENTHALER,[4] and L. ALBERS[5]

ABSTRACT

Gliadin proteins were characterized in sugar snap cookies from eight flours representing both soft and hard wheats varying widely in protein contents and functional properties that were baked by a conventional method or steamed. The methods used for gliadin characterization included polyacrylamide gel electrophoresis and high-pressure liquid chromatography. Chromatographic peaks of highly hydrophobic gliadin proteins extracted from steamed cookies were smaller than those extracted from baked cookies; the decrease was larger in good than in poor cookie flours. The results indicated that binding (inextractability) of gliadin proteins during baking varies with end-use properties of cookie flours, type of baked product, and type and length of baking regime.

Cereal Chem. 66(6):532–534

The contribution of gluten, and especially gliadin, proteins to breadmaking was reviewed by Pomeranz (1985, 1987, 1988). We recently reported on changes taking place in gliadin proteins during breadmaking (Menkovska et al 1987, 1988). Polyacrylamide gel electrophoretic (PAGE) gliadin bands with low relative mobility (ω-gliadins) were equal or more intense (stronger) and those with high relative mobility (α-, β-, and γ-gliadins) were less intense (weaker) in the extract of the bread crumb than those bands found in the extract of the corresponding flour. High-pressure liquid chromatographic (HPLC) analysis of gliadin extracts from bread crumb indicated that the highly hydrophobic gliadins were more reactive (bound) than less hydrophobic gliadins. The changes were more pronounced in good than in poor breadmaking flours. Little is known about the role of gliadins in cookie making. We now report changes that occur in gliadin proteins when flours are made into regular snap or steamed cookies.

[1]Cooperative investigations, U.S. Department of Agriculture, Agricultural Research Service and the Department of Grain Science and Industry, Kansas State University. Contribution 88-75-J, Department of Grain Science and Industry, Kansas Agricultural Experiment Station, Manhattan.

Mention of firm names or trade products does not constitute endorsement by the U.S. Department of Agriculture over others not mentioned.

[2]Research chemists, U.S. Grain Marketing Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, 1515 College Avenue, Manhattan, KS 66502.

[3]Present address: Research professor, Dept. of Food Science and Human Nutrition, Washington State University, Pullman 99164-2032.

[4]Research food technologist, Western Wheat Quality Laboratory, ARS-USDA, Pullman, WA 99164.

[5]Research assistant, Department of Grain Science and Industry, Kansas State University, Manhattan 66506.

This article is in the public domain and not copyrightable. It may be freely reprinted with customary crediting of the source. American Association of Cereal Chemists, Inc., 1989.

MATERIALS AND METHODS

The eight flours used in this study are described in Table I. They were milled from wheat grown at Pullman, WA, from the 1984 crop. WA 7215 was a composite from the Western Regional White Winter Wheat Nursery of 1984. The wheats were micromilled as described by Pomeranz et al (1985). The wheats were selected to include the main types produced in the Pacific Northwest: club, soft white winter (SWW), hard white winter (HWW), and hard red winter (HRW). Except for the HWW WA 7215, the flours were low in protein and, in general, considered suitable for cookie production. However, as indicated in Table I and Figure 1, the sugar snap cookies baked from these flours differed widely in diameter. The first four flours in Table I produced (based on cookie diameter) satisfactory cookies; the others were evaluated as decreasingly questionable to unsatisfactory. The three hard wheats were unsuitable for cookie production.

Protein, moisture, and ash values of the flours were determined according to AACC procedures (1976). Mixograph water absorption was determined according to the procedure of Finney and

TABLE I
Characteristics of Flours Used in the Study

Variety or Selection	Class[a]	Yield[b] (%)	Protein (%, N × 5.7)[b]	Ash[b] (%)	Mixograph Absorption[b] (%)	Cookie Diameter (cm)
Moro	Club	74.5	7.8	0.35	52.4	9.58
ORCW 8314	SWW	74.3	7.1	0.38	53.7	9.39
Dusty	SWW	74.7	8.0	0.36	54.0	9.15
Nugaines	SWW	70.7	6.8	0.33	54.2	8.94
SN 121-81	Club	70.3	7.1	0.40	57.5	8.66
Burt	HWW	67.5	8.0	0.35	59.5	8.30
Hatton	HRW	69.2	7.7	0.36	60.6	8.10
WA 7215	HWW	69.9	10.2	0.43	62.3	7.65

[a] SWW = soft white winter, HWW = hard white winter, HRW = hard red winter.
[b] 14% moisture basis.

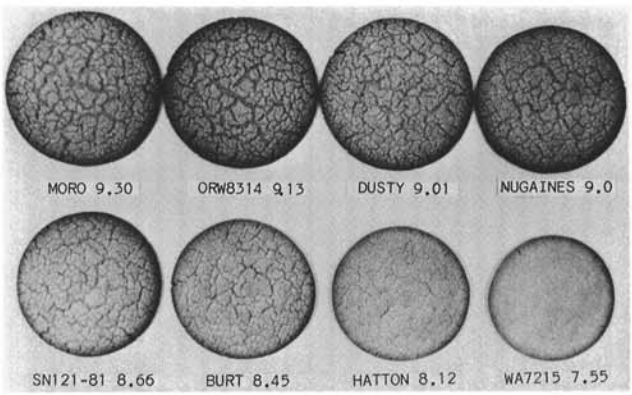

Fig. 1. Regular cookies baked from eight flours used in this study.

Shogren (1972). Regular snap cookies were baked using the procedures of Finney et al (1950) and Sollars and Barrett (1964). Cookies were baked from 20 g of flour at 204°C for 10 min or steamed at 100°C for 20 min. The cookies were broken up, ground in a mortar, and defatted exhaustively with petroleum ether in a Soxhlet apparatus prior to extraction of gliadin proteins for PAGE and HPLC examination. The solvent from the cookies was allowed to evaporate at room temperature until no petroleum ether odor was detected, and the defatted cookies were ground on a micro-Wiley mill to pass a 20-mesh sieve. Defatted cookies were extracted with 70% ethanol and analyzed by PAGE and HPLC methods as described by Menkovska et al (1987a,b).

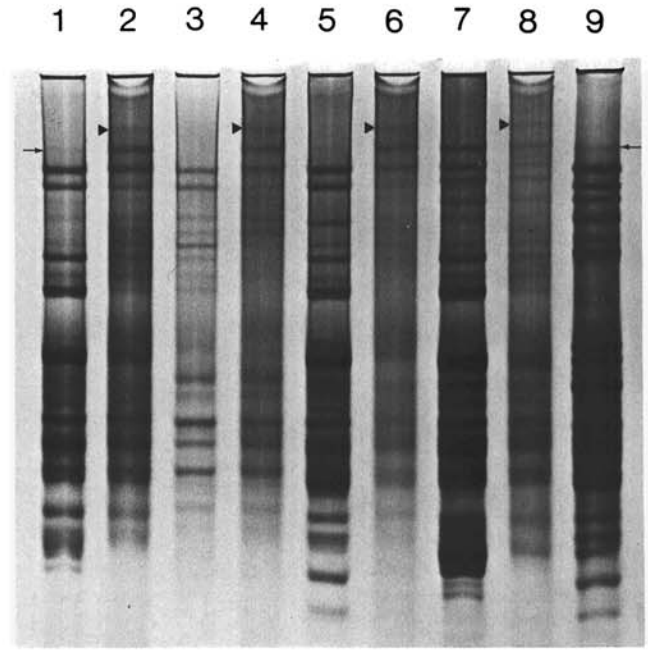

Fig. 2. Electrophoregrams of gliadins extracted from flours (lanes 1, 3, 5, and 7) and corresponding snap cookies (2, 4, 6, and 8) of soft white winter wheat cultivar Dusty, soft white winter wheat selection ORCW 8314, club selection SN 121-81, and hard white winter wheat selection WA 7215, respectively. Pattern 9 is for the reference hard red spring cultivar Marquis.

RESULTS AND DISCUSSION

Mixograph water absorption and cookie diameter (Table I) were highly correlated ($r = -0.983$). Electrophoregrams of gliadins extracted from four flours and corresponding baked cookies are compared in Figure 2. Basically, there was a substantial and consistent reduction in intensity of most electrophoretic bands from slow-moving ω-gliadin for flour extracts to cookie extracts. Similar results were found for the other four pairs of flours and cookies (not shown).

Because the gliadins were extracted from a constant weight (250 mg) of each sample and were otherwise treated identically, the band intensities of the sugar-rich cookie extracts would be expected to be about two-thirds as intense as those from flour components. However, since Coomassie stain is not quantitative, only semiquantitative and qualitative visual information could be obtained. Consistent increases were found in the intensities of a slow-moving ω-gliadin band in cookie extracts versus flour extracts (Fig. 2, marked with →). It appears that baking (heating) increases solubility of the slowest moving ω-gliadins and decreases the solubility of most other gliadins or causes polymerization of lower molecular weight proteins into ones of higher molecular weight. An additional band (marked >) was found at the top of the gel for each of the baked cookie extracts.

For comparison of HPLC patterns (Fig. 3), we selected four flours: a low-protein HRW (Hatton), a low-protein SWW of medium cookie-making quality (Dusty), a low-protein SWW of good cookie-making quality (ORCW 8314), and a medium-protein HWW bread type (WA 7215). A similar general picture was obtained during examination of HPLC elution patterns of the other four flours (Moro, Nugaines, SN 121-81, and Burt; not shown here). The peak areas of eluted peaks were lower for extracts of cookies (B and C, Fig. 3) than for extracts of the corresponding flours (A, Fig. 3), especially for peaks eluting after 23 min. The decrease was larger for the steamed cookies (B) than for the baked cookies (C). The reason for the difference is not known; it could be due to the longer heat treatment, albeit at lower temperature, of steamed cookies (20 min) than of baked cookies (10 min). However, Schofield et al (1983) found that the damage in gluten samples heated over 75°C was done within 2 min. Therefore, the method and/or rate of heat penetration may have affected the inextractability of some gliadin proteins.

Highly hydrophobic gliadins (elution times about 23 min) decreased more in cookies (especially steamed) baked from good, soft wheat flours (Dusty and ORCW 8314) than from poor, hard wheat flours (Hatton and WA 7215).

The results indicated that inextractability of hydrophobic gliadin proteins during cookie baking varies with end-use prop-

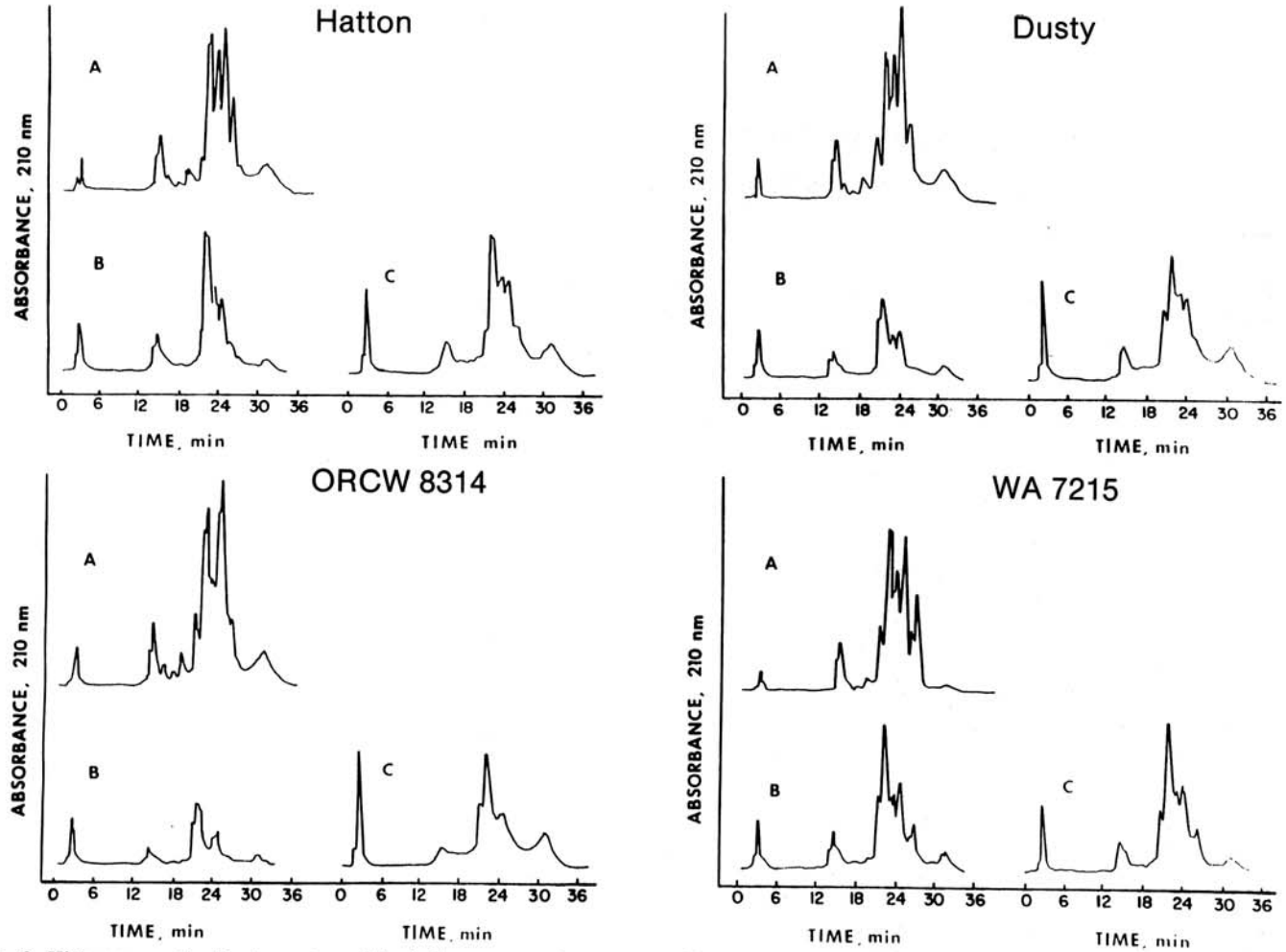

Fig. 3. High-pressure liquid chromatographic elution patterns for extracts of flours (A) steemed cookies (B), and regular cookies (C) for hard red winter cultivar Hatton, soft white winter wheat cultivar Dusty, soft white winter selection ORCW 8314, and hard white winter wheat selection WA 7215.

erties of flours, type of baked product, and type and length of heating-baking regime.

LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1976. Approved Methods of the AACC. Method 08-01, approved April 1961; Method 44-15A, approved October 1975; Method 46-11, approved October 1976. The Association: St. Paul, MN.

FINNEY, K. F., and SHOGREN, M. D. 1972. A ten-gram mixograph for determining and predicting functional properties of wheat flours. Baker's Dig. 46(2):32.

FINNEY, K. F., MORRIS, V. H., and YAMAZAKI, W. T. 1950. Micro versus macro cookie-baking procedures for evaluating the cookie quality of wheat varieties. Cereal Chem. 27:42.

MENKOVSKA, M., LOOKHART, G. L., and POMERANZ, Y. 1987. Changes in the gliadin fraction(s) during breadmaking: Isolation and characterization by high-performance liquid chromatography and polyacrylamide gel electrophoresis. Cereal Chem. 64:311.

MENKOVSKA, M., POMERANZ, Y., LOOKHART, G. L., and SHOGREN, M. D. 1988. Gliadin in crumb of bread baked from high-protein wheat flours of varied breadmaking potential. Cereal Chem. 65:198.

POMERANZ, Y. 1985. Functional Properties of Food Components. Academic Press: Orlando, FL.

POMERANZ, Y. 1987. Modern Cereal Science and Technology. VCH Publishers: New York.

POMERANZ, Y., ed. 1988. Wheat: Chemistry and Technology. vols. 1 and 2. Am. Assoc. Cereal Chem.: St. Paul, MN.

POMERANZ, Y., BOLTE, L. C., FINNEY, K. F., and SHOGREN, M. D. 1985. Effect of variations in tempering on micromilling of hard winter wheat. Cereal Chem. 62:47.

SCHOFIELD, J. D., BOTTOMLEY, R. C., TIMMS, M. F., and BOOTH, R. 1983. The effect of heat on wheat gluten and the involvement of sulfhydryl-disulfide interchange reactions. J. Cereal Sci. 1:241.

SOLLARS, W. F., and BARRETT, F. F. 1964. Soft wheat flour evaluation at the Western Wheat Quality Laboratory. Baker's Dig. 38(3):34.

[Received May 5, 1989. Revision received September 11, 1989. Accepted September 14, 1989.]