Evaluating Cookie Spread Potential of Whole Wheat Flours from Soft Wheat Cultivars[1]

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ABSTRACT

Methods for evaluating whole wheat flour cookie spread potential were compared. The following were statistically evaluated for correlation with whole wheat flour sugar-snap cookie diameter: particle size index, straight-grade flour MacMichael viscosity, and sugar-snap cookie diameter; whole wheat flour alkaline water retention capacity, whole wheat temper, and level and extent of grinding; whole wheat flour particle size and ash, protein, and moisture contents; and whole wheat flour cookie dough liquid level. Because no good predictive correlations were found across cultivars, whole wheat cookie spread potential was concluded to be evaluated best by test baking and measuring cookie diameter. Cultivars with a softer kernel texture produced larger whole wheat cookies. Within a cultivar, whole wheat flour cookie size was significantly affected by flour particle size and moisture content.

An increase in usage of soft red and white wheats as whole wheat flour raises questions of how to evaluate soft wheat cultivars for whole wheat product end use—especially, cookie quality potential. Increasing flour lipid content causes greater cookie spread (Kissell et al 1971); wheat bran lipids also have this effect (Yamazaki et al 1979). Conversely, it has been reported that when wheat bran is added to sugar-snap cookies, cookie spread decreases (Vratanina and Zabik 1978, Jeltema et al 1983). Whole wheat flour contains 1–2% more protein and approximately twice the amount of total lipid as does straight-grade flour from the same wheats. Higher protein content in straight-grade flours has also been shown to reduce sugar-snap cookie size (Yamazaki 1954). Given that whole wheat flour contains more lipid, bran, and protein than does straight-grade flour, do data from the quality testing of straight-grade flours correlate with the size of sugar-snap cookies made with whole wheat flours? Can the spread of whole wheat cookies be adequately predicted from the diameter of cookies made from straight-grade flours or from straight-grade or whole wheat flour alkaline water retention capacity (AWRC), protein content, or MacMichael viscosity? How well do the standard soft wheat quality testing methods adapt to whole wheat flours? The objective of this study was to answer these questions.

MATERIALS AND METHODS

Wheats and Milling

A total of 69 red and white soft wheat cultivars and experimental test lines representing several crop years and locations of growth were tempered to 14% and milled into straight-grade flours on an Allis-Chalmers mill (Yamazaki and Andrews 1982) and into whole wheat flours by processing approximately 140 g through a falling number mill (model KT-3303), using the medium burr grinding heads at the closest setting for three passes unless otherwise specified. All straight-grade and whole wheat flours were evaluated for AWRC (Yamazaki et al 1968) and protein content (AACC 1983).

Flour Analysis

Wheats were divided into subsets depending on available quantity. Test weight, particle size index (Yamazaki and Donelson 1983), and kernel ash and kernel protein contents (AACC 1983) were determined on 33 wheat samples. Straight-grade flours from these wheats were also evaluated for MacMichael viscosity (AACC 1983), endosperm separation index (Yamazaki and Andrews 1982), and break flour yield (Yamazaki and Andrews 1982). Viscosity was measured with a Brookfield Viscosimeter (Kitterman 1974), converted to degrees MacMichael and 0.42% ash and 10% protein levels. Forty-nine whole wheat flours were analyzed for mean volume diameter of particle size by a Microtrac model 7991-01 particle size analyzer (Leeds and Northrup, St. Petersburg, FL), using a dry powder attachment.

Cookie Baking

All 69 flours were baked into cookies using the Micro-Method III formulation of Finney et al (1950). Whole wheat flours required approximately the same optimum dough liquid levels as did the corresponding straight-grade flours (17.5% of flour weight, 7 ml total liquid).

Grinding Passes and Tempering Levels

The effects of the the number of grinding passes (one to five) through the falling number mill on whole wheat cookie diameter, AWRC, and flour particle size were evaluated on three cultivars chosen to represent excellent and good straight-grade flour quality. These three wheats were also used to evaluate the effect of temper level on whole wheat cookie diameter and flour moisture content. Wheats (140 g) were tempered to 12, 13, 14, 15, and 16% moisture, equilibrated overnight, and ground with three grinder passes. Two different flour composites were made by combining portions of the 33 whole wheat flours. These two composites were used to evaluate the effect of dough liquid level on whole wheat cookie diameter.

All data are means of duplicate or triplicate observations. Standard error values are 0.19 cm for whole wheat flour cookie diameter, 0.22 cm for straight-grade flour cookie diameter, 2.6 μm for whole wheat flour particle size diameter, and 0.67% for whole wheat flour AWRC.

RESULTS AND DISCUSSION

The influence of the extent of grinding (number of passes through the grinder) on whole wheat flour particle size, whole wheat cookie diameter, and whole wheat AWRC was studied, using three soft red winter wheat cultivars (Fig. 1). As the number of grinding passes increased from one to three, flour particle size, AWRC, and cookie spread decreased. Increasing the grinding passes to four or five caused no significant change in these parameters. Each wheat attained a different minimum particle size, which was cultivar-dependent rather than related to the number of grinder passes. Whole wheat cookie diameter probably decreased as a result of increased water sorption on the enlarged surface area as grinding continued to three passes. This would result in less available free water, causing higher dough viscosity and less cookie

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spread during baking. AWRC values probably decreased as particle size was reduced, because larger particles tend to entrap the alkaline-buffered water rather than allow it to drain from the flour gel in the test tubes. After the flour particles were reduced to a certain size (which appeared to be cultivar-dependent), further reduction of particle size did not continue to decrease AWRC. Relative whole wheat cookie diameter of these three cultivars did not appear related to whole wheat AWRC values.

As the temper level was increased from 13 to 16%, cookie spread increased (Fig. 2a). The moisture content of these flours was approximately 0.2% less than the temper levels. Although flour weight was adjusted for moisture content (14% moisture basis), increased flour moisture content resulting from higher temper levels caused increased cookie spread. When these flours were dried to the same approximate moisture content (12%), the temper level had no discernible effect on whole wheat cookie size (Fig. 2b). Temper level did not significantly affect whole wheat flour particle size or AWRC when evaluated on an "as is" flour moisture basis.

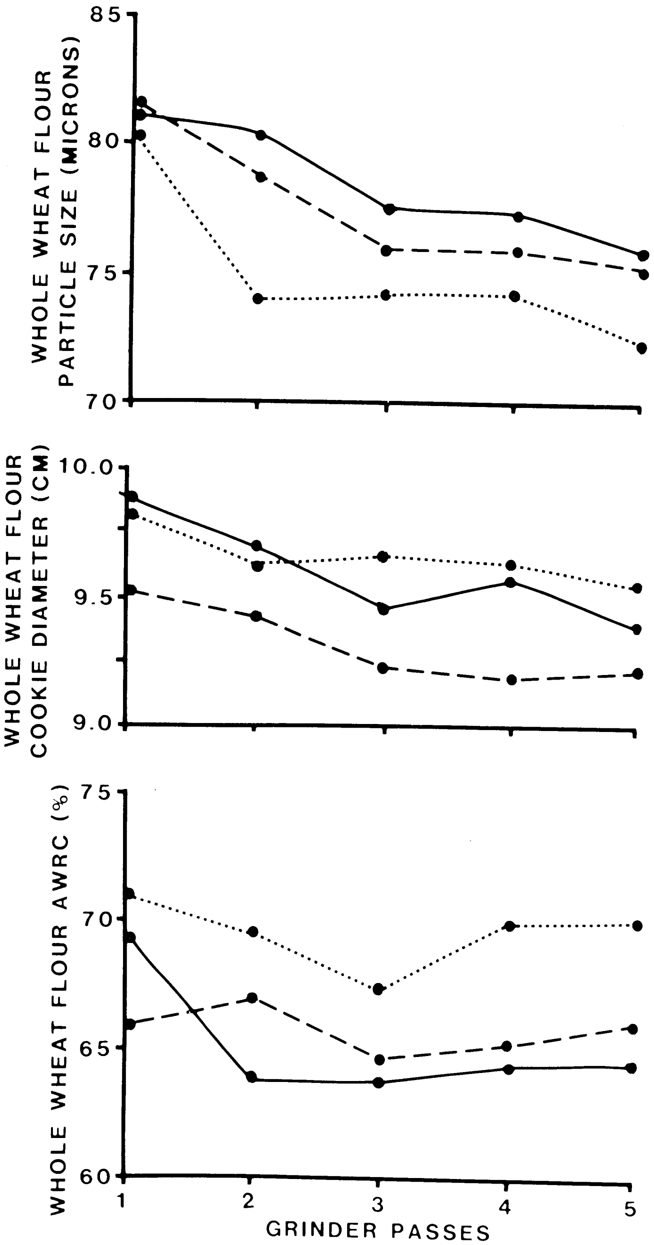

Fig. 1. Effect of the number of grinder passes (extent of grinding) on flour particle size, cookie diameter, and AWRC for whole wheat flour from three soft wheat cultivars. Solid and dotted lines represent wheats with excellent straight-grade flour quality; the dashed line represents a wheat with good straight-grade flour quality.

The 13% temper level had the best flow properties during grinding. As dough water level increased from 7 to 11 ml (17.5–27.5% of flour weight), whole wheat cookie diameter first increased and then decreased (Fig. 3). The decrease may be a reflection of greater gluten development during mixing from quicker protein hydration

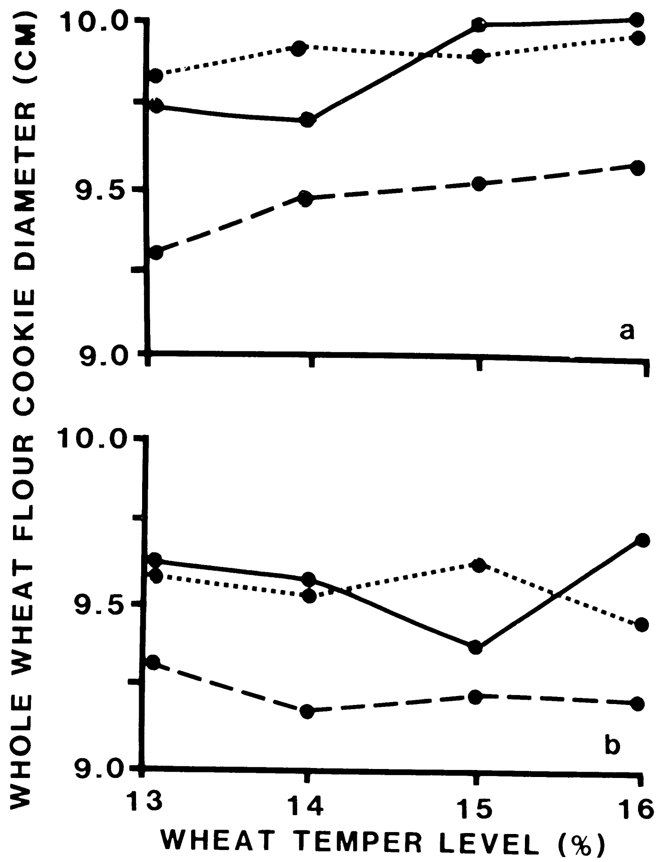

Fig. 2. Effect of wheat temper level on cookie diameter for whole wheat flour from three cultivars: a) "as is" flour moisture content; b) flour dried to approximately 12% moisture content. Solid and dotted lines represent wheats with excellent straight-grade flour quality; the dashed line represents a wheat with good straight-grade flour quality.

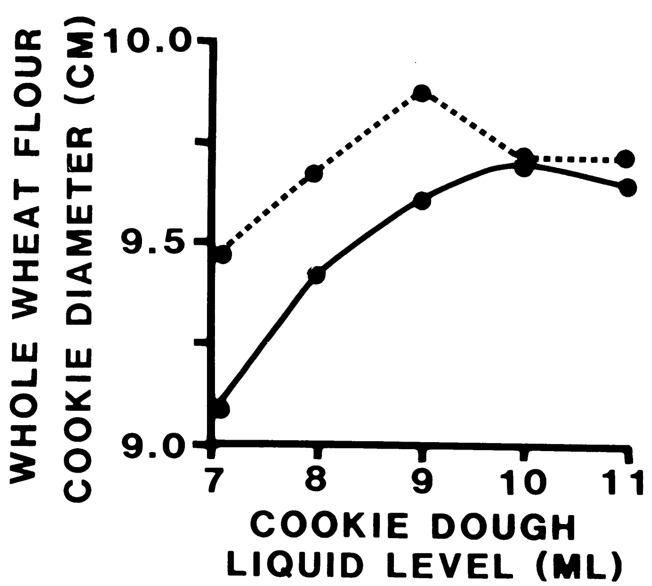

Fig. 3. Effect of cookie dough liquid level on cookie diameter for whole wheat flour from two composite flours. The dotted line represents a flour with excellent straight-grade flour quality, and the solid line represents a flour with good straight-grade flour quality.

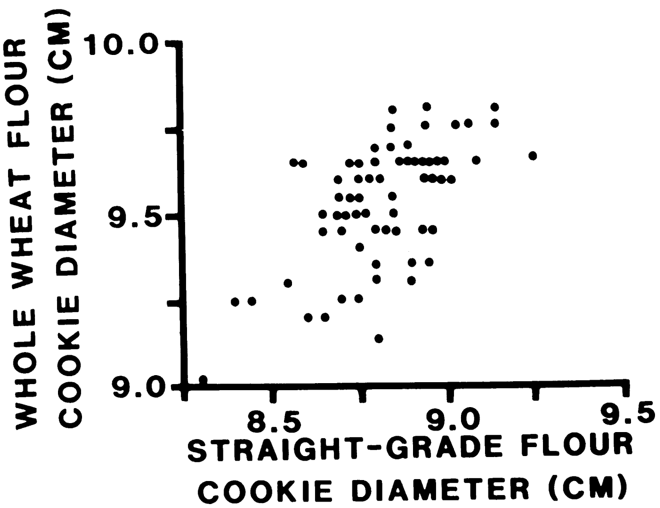

Fig. 4. Relationship between whole wheat and straight-grade cookie diameters for 64 soft wheat cultivars.

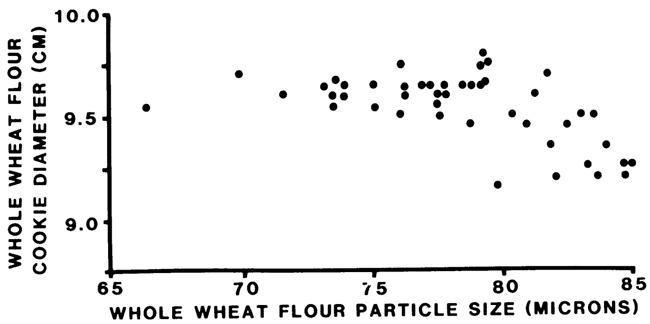

Fig. 5. Relationship between whole wheat flour particle size and cookie diameter across 46 soft wheat cultivars.

at the higher dough liquid levels, or of increased starch gelatinization during baking.

Whole wheat cookie spread was not significantly correlated with whole wheat protein or ash contents, wheat test weight, particle size index, or straight-grade flour MacMichael viscosity. Straight-grade flour AWRC is often used to predict straight-grade flour cookie diameter. In this study, whole wheat cookie diameter was significantly correlated with whole wheat flour AWRC ($r = -0.78$, $n = 64$, $P = 0.001$) and straight-grade cookie diameter ($r = 0.64$, $n = 64$, $P = 0.001$). However, neither correlation is strong enough to be a good predictor of whole wheat cookie diameter.

The mean whole wheat cookie diameter of 64 soft red and white wheat cultivars was 0.7 cm larger than the corresponding straight-grade cookie diameters (8.8 vs. 9.5 cm) (Fig. 4). This suggests that the contribution of whole wheat lipids to larger cookie spread was greater than the counter influence of whole wheat bran particles. Whole wheat contains roughly twice the lipid content of straight-grade flour (Pomeranz et al 1966).

The mean volume particle size diameter (from three grinder passes) across 46 whole wheat flours was negatively correlated with whole wheat cookie diameter ($r = -0.56$, $P = 0.001$) (Fig. 5). This may appear to be contrary to the results from the three flours used in the grinding studies, in which a positive correlation was observed (up to three grinding passes). In the present circumstance (across cultivars), coarser granulating whole wheat flours apparently make smaller cookies because they represent harder textured wheats. In fact, whole wheat particle size was negatively correlated with kernel hardness as measured by the particle size index ($r = -0.90$, $n = 23$) and with break flour yield ($r = -0.86$, n = 23). A lower particle size index and break flour yield signify a harder wheat cultivar, which usually makes smaller cookies.

CONCLUSIONS

The significant correlation between whole wheat flour cookie diameter and straight-grade flour cookie diameter suggests that straight-grade flour cookie diameter can be used to predict whether a particular cultivar will behave like a typical soft whole wheat flour. However, a precise prediction of whole wheat cookie spread potential of soft wheat cultivars or blends can best be evaluated by test baking, rather than by predicting relative whole wheat cookie size from the usual quality testing methods applied to straight-grade flours. When test baking, care must be taken to standardize the extent of grinding (flour particle size), flour moisture content (especially from variation in kernel temper level), and dough liquid level. With this cookie formulation, the cookie spread reducing (hydrophilic) influence of whole wheat bran is more than counterbalanced by the cookie spread increasing effect of whole wheat lipids, which creates larger whole wheat cookies than do corresponding straight-grade flours. Wheat cultivars of softer kernel texture generally produce larger sugar-snap cookies when made with straight-grade flour. This study shows the same is true when cookies are made with whole wheat flour.

LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1983. Approved Methods of the AACC. Methods 8-01 and 56-80, approved April 1961; Method 46-12, approved October 1976. The Association: St. Paul, MN.

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.

JELTEMA, M. A., ZABIK, M. E., and THIEL, L. J. 1983. Prediction of cookie quality from dietary fiber components. Cereal Chem. 60:227.

KISSELL, L. T., POMERANZ, Y., and YAMAZAKI, W. T. 1971. Effects of flour lipids on cookie quality. Cereal Chem. 48:655.

KITTERMAN, J. S. 1974. An improved Brookfield viscosity test. Cereal Science Today 19:285.

POMERANZ, Y., CHUNG, O., and ROBINSON, R. J. 1966. Lipids in wheat from various classes and varieties. J. Am. Oil Chem. Soc. 43:511.

VRATANINA, D. L., and ZABIK, M. E. 1978. Dietary fiber sources for baked products: bran in sugar-snap cookies. J. Food Sci. 43:1,590.

YAMAZAKI, W. T. 1954. Interrelationships among bread dough absorption, cookie diameter, protein content, and alkaline water retention capacity of soft winter wheat flours. Cereal Chem. 31:135.

YAMAZAKI, W. T., and ANDREWS, L. C. 1982. Experimental milling of soft wheat cultivars and breeding lines. Cereal Chem. 59:41.

YAMAZAKI, W. T., and DONELSON, J. R. 1983. Kernel hardness of some U.S. wheats. Cereal Chem. 60:344.

YAMAZAKI, W. T., DONELSON, J. R., and BRIGGLE, L. W. 1968. Micro-tests for soft wheat quality evaluation. Crop Sci. 8:199.

YAMAZAKI, W. T., DONELSON, J. R., and CLEMENTS, R. C. 1979. Note: effect of brand lipids on cookie quality. Cereal Chem. 56:584.

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