Effects of Wheat Bran and Polydextrose on the Sensory Characteristics of Biscuits

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ABSTRACT

Rolled biscuits were prepared with wheat bran replacing 0, 14, 28, and 42% of the flour and with polydextrose replacing 0, 20, 40, and 60% of the hydrogenated shortening in the formula. In all, 16 different combinations were evaluated. Response surface methodology was used to illustrate sensory characteristics of the biscuits. Panelists rated biscuits more crumbly, drier, and chewier as bran level increased. Aftertaste and wheat flavor were greater in biscuits that contained wheat bran. Panelists scored biscuits made with polydextrose as more moist but no more chewy or cohesive than biscuits made without polydextrose. Polydextrose appeared to overcome some of the effects of wheat bran in biscuits.

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Several researchers have successfully used wheat bran to enhance the nutritional quality of baked products such as cookies, cakes, yeast breads, and muffins. Often, the addition of wheat bran affects the physical and sensory properties of the baked products. Wheat bran supplemented cookies (Jeltema et al 1983, Vratania and Zabik 1980), cakes (Brockmole and Zabik 1976, Shafer and Zabik 1978, Springsteen et al 1977), and breads (Cadden et al 1983, Pomeranz et al 1977) all had physical properties that differed from the control. In the majority of studies reviewed, most sensory attributes of baked products were not affected adversely by the addition of wheat bran. This held true for cookies (Jeltema et al 1983, Vratania and Zabik 1980), cakes (Shafer and Zabik 1978, Springsteen et al 1977), yeast breads (Cadden et al 1983), and muffins (Polizotto et al 1983).

Reduction of fat in baked products has proven to be more challenging and less frequently addressed than addition of wheat bran. Ways to reduce the fat content of baked products have been explored (Berglund and Hertsgaard 1986, Bruinsma and Finney 1984, Harnett and Thalheimer 1979, Kamel and Washnuik 1983, Neville and Setser 1986, Smith 1984). Studies have been conducted to determine optimum levels of fat rather than optimum reduced levels (Abboud et al 1985, Finney et al 1950, Matthews and Dawson 1966). Of the studies that investigated optimum reduced levels of fat achievable in baked products, only three used lower calorie substitutes for the fat (Kamel and Washnuik 1983, Neville and Setser 1986, Smith 1984). The researchers who worked with low-calorie fat substitutes were able to reduce the levels of fat and calories in baked products more than researchers who only decreased the quantity of fat. In addition, the low-calorie fat substitutes used, N-Flate and polydextrose, produced cakes that were more similar to control cakes in terms of physical and sensory characteristics than cakes with decreased quantities of fat. A fat substitute with the same functional characteristics as the fat it is replacing is needed; otherwise, a reduced-fat baked product will differ significantly from a standard baked product. The objective of this study was to examine sensory properties of rolled biscuits prepared with varied levels of wheat bran and polydextrose. The objective was accomplished through the use of response surface methodology.

MATERIALS AND METHODS

A four-by-four treatment combination was used with a randomized incomplete block design. Four randomly selected rolled biscuit treatments were prepared each day over a 12-day period for a total of three replications of each treatment. Wheat bran (Mennel Milling Company, Charlotte, NC) was substituted for bread flour at four levels: 0, 14, 28, and 42% (fwb). The actual percentage of wheat bran in the total formula was 0, 6.6, 13.1, 19.8%, respectively. Hydrogenated shortening was replaced by polydextrose-K (Pfizer Chemical Company, New York, NY) at four levels: 0, 20, 40, and 60%. The actual percentage of polydextrose-K in the total formula was 0, 3.6, 7.2, or 10.5%, respectively. Polydextrose-K is a white to light tan powder composed of a randomly bonded polymer of D-glucose.

A rolled, buttermilk biscuit formula adapted from the Lauhoff Grain Company (Danville, IL) was used for the control. Amounts of bread flour, wheat bran, hydrogenated shortening, and polydextrose-K were varied as shown in Table I. Other ingredients were as follows: sucrose, 17 g; NaCl, 8 g; baking powder, 20 g; baking soda, 4 g; buttermilk solids, 56 g; water, 230 g. The dry ingredients were sifted and mixed together. Shortening or the shortening-polydextrose mixture was cut into the dry ingredients mechanically for 90 sec. Water was incorporated mechanically for an additional 20 sec to form a dough. The dough was kneaded 24 times and rolled to a uniform thickness using 1.25-cm metal guide bars spaced 20 cm apart. Biscuits were cut by hand with a 5.1-cm diameter cutter. Biscuits were baked at 218°C for 10 min, cooled to ambient temperature, and enclosed in plastic bags. Testing was begun on room temperature biscuits approximately 1 hr and 15 min after removal from the oven.

A six-member panel, one male and five females, was trained for a total of 6.25 hr over 10 days by the researchers. Panelists were selected on the basis of availability, ability, and interest. Panelists attended six training sessions of 1 hr each and one practice evaluation session.

Using a standard rolled biscuit, attributes were identified, discussed, and defined by panelists. Panelists discussed directions for evaluation and scorecard usage. By day six of training, attributes to be analyzed during the study were firmly established. Attributes included textural, flavor, and visual parameters. Hardness, cohesiveness, chewiness, and moistness were the textural attributes analyzed. Hardness was defined as the force required to compress the sample. Panelists were asked to set the biscuit on a flat surface and uniformly press the center of the biscuit with the index finger extended. Cohesiveness was defined as the strength of internal bonds as related to crumbliness. Length of time required to masticate sample and amount of saliva required

TABLE I
Weight (g) of Variable Ingredients in the Control Biscuit and in Biscuits Containing Different Amounts of Wheat Bran and Polydextrose

		Wheat Bran (%)			Polydextrose (%)		
Ingredient	Control[a]	6.6	13.1	19.8	3.6	7.2	10.5
Bread flour	448	385	323	260	448	448	448
Wheat bran	...	63	125	188	...	...	...
Shortening	168	168	168	168	134	100	68
Polydextrose	...	...	...	...	34	68	100

[a] Control formula = 0% wheat bran and 0% polydextrose.

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to prepare sample for swallowing were the definitions for chewiness and moistness. Flavor components identified as important were wheat flavor and nonwheat aftertaste. Interior color was the only visual characteristic chosen for study.

Panelists recorded their perceptions of each attribute for each biscuit on unstructured, 150-mm line scales. Scales were anchored with parallel terms established by the panelists. A separate scorecard was used for each biscuit analyzed and placed in an envelope after evaluation, thereby preventing panelists from making direct comparisons among biscuits. Panelists indicated the intensity of the characteristic by placing a vertical line on the horizontal scale. Distance (in millimeters) from the left end of the scale to the vertical line was recorded by the researcher and was the score assigned to the characteristic.

Panelists were in individual booths; each was presented with four biscuits at each of the 12 panel sessions. Biscuits for daily evaluation were determined with a randomized incomplete block design. Each biscuit, coded with a three-digit random number, was presented in a separate plastic bag sealed with a twist tie. To discourage panelists from comparing biscuits, each biscuit was covered with an inverted, opaque container.

Analysis of variance was performed using Proc GLM software (SAS 1986) to test the effects of wheat bran and polydextrose on each of the response variables. Least squares means and the standard errors of the least squares means were generated for later use in creating response surfaces. Also, the effects of wheat bran and polydextrose were partitioned into their linear, quadratic, and cubic portions. The model was then applied to the least squares means for generating the response surfaces.

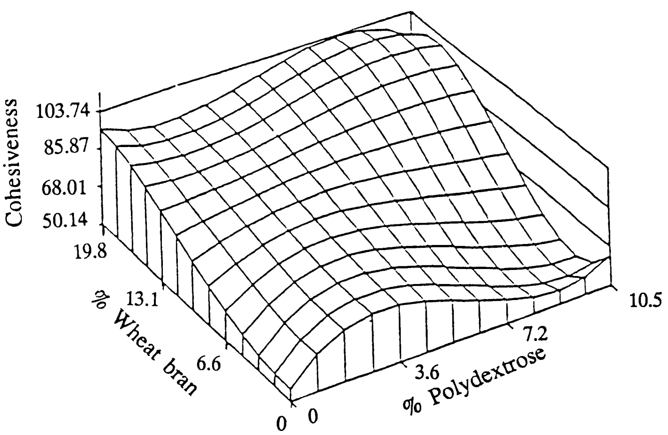

Fig. 1. Response surface for sensory cohesiveness (1 = slightly crumbly, 150 = crumbly) of biscuits as a function of percentage of wheat bran and polydextrose (note inverse scale).

RESULTS AND DISCUSSION

No significant differences were detected for biscuit hardness. Panelists compressed biscuits with the index finger to detect hardness. During the training session, panelists indicated that they experienced difficulty in detecting differences in hardness by compressing the biscuits between molars. Possibly, the manual method used to detect hardness sensorially as well as the method not used was not sensitive enough to detect differences among the treatments studied.

Wheat bran exhibited a significant main, linear, and cubic effect for cohesiveness. Low spots on Figure 1 indicate a high degree of cohesiveness and high spots indicate a low degree. In general, as wheat bran was substituted for more flour, biscuits became less cohesive and more crumbly (Fig. 1). As wheat bran increased, gluten proteins, responsible for the cohesiveness or structure of baked products, were diluted and the formation of gluten became more difficult. Wheat bran particles probably interfered with the development of gluten complex.

Cohesiveness generated the most complex surface of the sensory scores; many peaks and troughs are visible on the response surface (Fig. 1). Although polydextrose did not produce a significant main effect, a significant quadratic effect was seen.

Wheat bran showed a linear effect for moistness in that as more wheat bran was added, biscuits became drier and required more saliva to masticate (Fig. 2). The drying effect of wheat bran might be explained by its water-absorptive properties. Both wheat bran and flour absorb water, but during baking wheat bran may lose water more readily than flour. Biscuits containing wheat bran had less flour; consequently, less water may have remained after baking and the resultant biscuits therefore were perceived as dry by panelists.

Polydextrose produced a linear effect for moistness (Fig. 2). Adding polydextrose made biscuits slightly more moist as perceived by panelists, thereby, slightly lessening the drying effect of the wheat bran. Polydextrose is noted for its hygroscopic properties (Freeman 1982, Torres and Thomas 1981), which may explain why biscuits containing polydextrose were perceived as more moist than biscuits without it.

Biscuits made with more wheat bran were more chewy than biscuits made with less wheat bran (Fig. 3). Chewiness is related to moistness. Panelists defined chewiness as "length of time required to masticate sample." Drier biscuits required more time to absorb enough saliva so the bolus could be swallowed. Thus, dry biscuits were chewy. Biscuits perceived as driest contained 19.8% wheat bran.

Polydextrose had no effect on chewiness even though the panelists perceived it as having a moistening effect on the biscuits. Most likely, the moistening effect of polydextrose was not enough to effect chewiness.

Biscuits made with wheat bran received scores that indicated

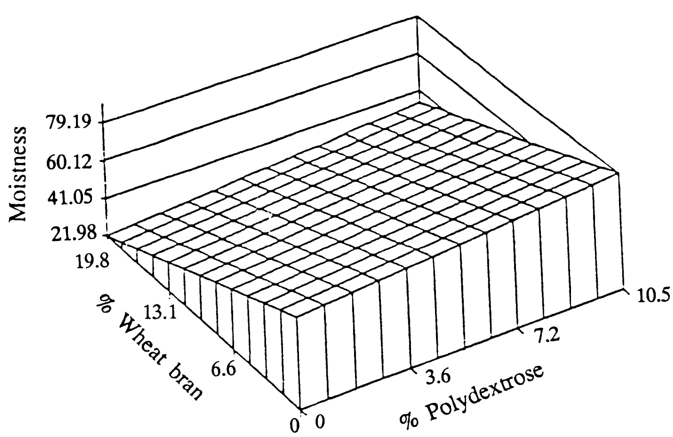

Fig. 2. Response surface for sensory moistness (1 = slightly moist, 150 = moist) of biscuits as a function of percentage of wheat bran and polydextrose.

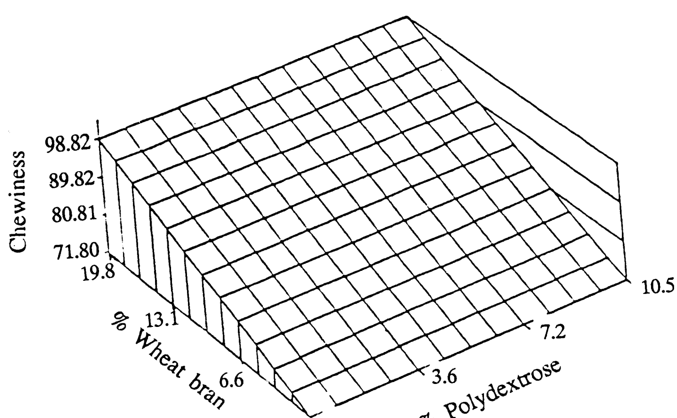

Fig. 3. Response surface for sensory chewiness (1 = slightly chewy, 150 = chewy) of biscuits as a function of percentage of wheat bran and polydextrose.

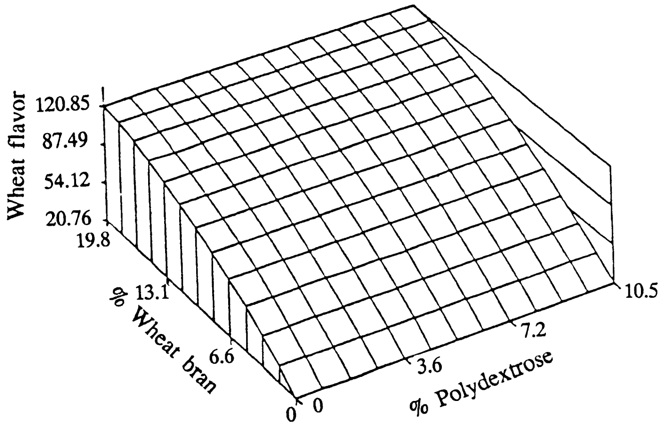

Fig. 4. Response surface of biscuit wheat flavor (1 = mild, 150 = strong) as a function of percentage of wheat bran and polydextrose.

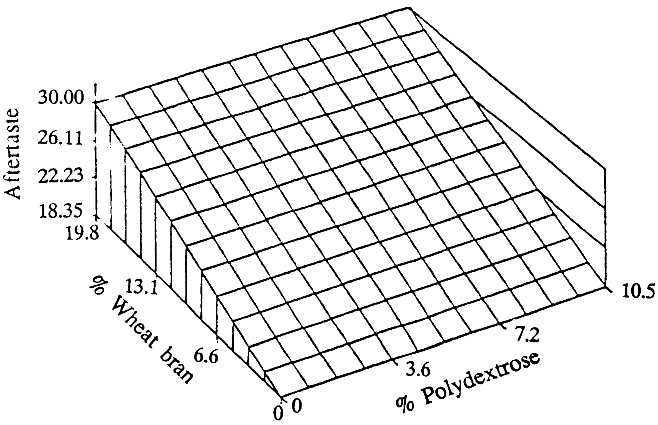

Fig. 5. Response surface of biscuit aftertaste (1 = slight, 150 = intense) as a function of percentage of wheat bran and polydextrose.

the biscuits were strong in wheat flavor. Panelists noted greater differences in the wheat flavor between biscuits containing 0 and 6.6% wheat bran than between those with 6.6 and 13.1% wheat bran (Fig. 4). Similarly, greater differences were noted between 6.6 and 13.1% wheat bran biscuits than between those that contained 13.1 and 19.8%. Polydextrose had no effect on wheat flavor and neither enhanced nor masked the wheat flavor contributed by wheat bran. Wheat bran conferred significant main and linear effects to the model for aftertaste. As wheat bran was added up to 19.8% in biscuits, nonwheat aftertaste became noticeable (Fig. 5). Aftertaste was identified by panelists as bitter, metallic, or salty.

Polydextrose played no role in the development of aftertaste. Neville and Setser (1986) found the opposite to hold true. Polydextrose acted synergistically with saccharin to produce a bitter aftertaste in model layer cakes.

Panelists perceived that wheat bran darkened the interior color of the biscuits (Fig. 6). Wheat bran is darker than flour and produced a darker colored biscuit. Polydextrose also had a linear influence, although darkening by polydextrose has not been documented. Polydextrose, a randomly bonded glucose polymer, would provide additional reducing sugars for Maillard browning to occur; thus, biscuits containing polydextrose should be darker in color than biscuits not containing polydextrose.

CONCLUSIONS

Panelists indicated biscuits were chewier, drier, crumblier, and darker as wheat bran level increased. Aftertaste and wheat flavor were greater in biscuits that contained wheat bran than in biscuits that contained no wheat bran. Panelists were unable to detect significant differences in hardness of biscuits; that is, neither wheat

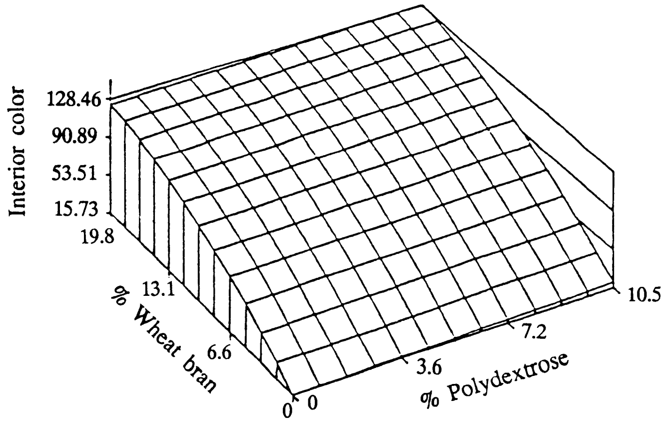

Fig. 6. Response surface for sensory interior color (1 = light, 150 = dark) of biscuits as a function of percentage of wheat bran and polydextrose.

bran nor polydextrose affected the hardness of biscuits as detected by sensory methods. Polydextrose did not affect chewiness, cohesiveness, wheat flavor, or aftertaste of biscuits. Polydextrose made biscuits darker, as did wheat bran; however, unlike wheat bran, polydextrose made biscuits more moist.

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