

NOTE

Use of Unheated and Heat-Treated Navy Bean Hulls as a Source of Dietary Fiber in Spice-Flavored Layer Cakes¹

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Epidemiological evidence has suggested that diets low in dietary fiber may contribute to diseases such as colonic cancer (Burkitt 1971), diverticulosis (Painter and Burkitt 1971), and various cardiovascular diseases (Spiller and Amen, 1975; Trowell, 1972). Cereal brans have been successfully incorporated into bread, cakes, and cookies to produce baked products with high fiber contents (Pomeranz et al 1977, Shafer and Zabik 1978, Vratana and Zabik 1978). Little research has been done, however, into the use of hulls from noncereal sources as types of dietary fiber. Shafer and Zabik (1978) compared cakes in which 30% of the flour was replaced with either soy hulls or wheat bran and found that the cakes prepared with soy hulls were inferior. Kalantari (1980) reported that up to 8% peanut hull flour could be successfully incorporated into whole wheat bread. In a companion study of potential uses for navy bean bran, we showed that acceptable sugar snap cookies can be prepared with navy bean bran roasted at 240°C, but incorporation of unheated navy bean bran was more successful than moderately heated navy bean bran (DeFouw et al 1982).

The aim of this investigation was to evaluate navy bean hulls as an alternative source of dietary fiber in spice-flavored layer cakes and to compare hull flour from beans with no heat treatment to hull flour from beans roasted for 2 min at 240°C.

MATERIALS AND METHODS

Navy Bean Hull Flour

Navy beans were unheated or heated for 2 min at 240°C in a particle-to-particle heat exchanger, resulting in a final product temperature of 125°C. They were then dehulled, and hulls were separated by aspiration as outlined by Aguilera et al 1982. The hulls were milled to a particle size resembling cornmeal.

Preparation of Cakes

The formulation for the cakes is presented in Table I. Unheated and roasted bean hulls were substituted for flour in the cake formula at the level of 15%. The dry ingredients were sifted together four times and mixed with the shortening, brown sugar, and buttermilk for 30 sec at low speed (98 rpm) using a KitchenAid K5-A mixer. The bowl was scraped, and the ingredients were mixed for an additional 2 min at medium speed (145 rpm). The eggs were added, then the batter was mixed for 30 sec at low speed, followed by scraping of the bowl and 2 min mixing at medium speed. A 350-g portion of the batter was scaled into paper-lined, 8-in. pans and baked for 37 min at 176.7°C. Four replications of a control cake were prepared. Cakes containing 15% unheated or 15% roasted navy bean hulls were also prepared.

Objective Measurements

Samples of batter were reserved from each baking for specific gravity and pH determinations. Viscosity of batter samples was also measured using a Brookfield Viscometer.

AACC method 10-91 (AACC 1962) was used to determine shrinkage and volume, symmetry, and uniformity. Compressibility and tenderness were measured with an Allo-Kramer shear press equipped with a TR-3 recorder. Moisture was determined on the cakes, using the AACC procedure 44-40 (AACC 1962). The pH of cakes was taken from a slurry of 15 g of cake and 100 ml of distilled water. A Hunter color difference meter was used to evaluate crumb color of each cake.

Sensory Evaluation

Color, moistness, tenderness, texture, flavor, and general acceptability were evaluated using a 10-point hedonic scale (10 = very desirable, 1 = very undesirable). A panel of six participants trained in organoleptic evaluation techniques evaluated the samples in individual booths equipped with daylight fluorescent light. All cake samples including the control were identified with random numbers.

Data Analyses

Analyses of variance and Tukey's multiple comparison tests as described by Gill (1978) were performed on all objective measures except pH and all sensory evaluations to identify significant differences at the 0.05 probability level.

RESULTS AND DISCUSSION

Results of the objective analyses performed on both the batter and the cakes are presented in Table II. The addition of 15% navy bean hulls resulted in a thicker batter, due to the high water absorbency of the hulls; however, only the batter containing the unroasted hulls was significantly more viscous than the control batter. Cakes prepared with the roasted navy bean hulls tended to be slightly more moist and tender than the control, yet these results were not significant.

Of the objective characteristics measured, only shrinkage of the cakes showed significant differences that could be attributed solely to heat treatment of the hulls. Shrinkage was greater for cakes prepared with the unheated hulls than for cakes prepared with roasted hulls, although neither differed significantly from the

TABLE I
Formulation for Spice-Flavored Layer Cake Controls

Ingredient	Amount	
	(g)	(%) ^a
Cake flour ^b	108.0	100.0
All-purpose flour	15.8	14.6
Granulated sugar	100.0	92.6
Brown sugar	25.0	23.1
Shortening	70.5	65.3
Salt	3.0	2.8
Soda	1.5	1.4
Baking powder	1.6	1.5
Cinnamon	0.5	0.5
Cloves	0.5	0.5
Fresh buttermilk	121.0	112.0
Whole egg	61.5	56.9

^aBased on cake flour (=100).

^bIn test cake, navy bean hull flour was substituted for flour at 15% of flour weight.

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TABLE II
Objective Analyses^a of Spice-Flavored Layer Cakes Prepared with 0% Navy Bean Hulls, 15% Unheated Bean Hulls and 15% Roasted Bean Hulls

Characteristic	Control	15% Substitution ^b	
		Unheated Hulls	Roasted Hulls
Batter			
pH	7.0 ± 0.2	6.9 ± 0.1	7.0 ± 0.1
Specific gravity	0.750 a ± 0.014	0.755 a ± 0.013	0.750 a ± 0
Viscosity (poise)	1128 a ± 81	1398 b ± 111	1165 ab ± 171
Cake			
pH	7.4 a ± 0.1	7.2 a ± 0.1	7.3 a ± 0.1
Moisture (%)	21.68 a ± 1.37	21.06 a ± 1.41	23.17 a ± 1.16
Shrinkage (cm)	1.0 a ± 0.2	1.3 b ± 0.1	1.0 a ± 0.6
Volume index (cm)	10.6 a ± 0.4	10.2 a ± 0.2	10.8 a ± 0.3
Symmetry index (cm)	0.7 a ± 0.3	0.5 a ± 0.2	0.7 a ± 0.2
Uniformity index (cm)	0.2 a ± 0.1	0.1 a ± 0	0.2 a ± 0.2
Tenderness (lb/g)	2.39 a ± 0.16	2.12 a ± 0.20	2.29 a ± 0.74
Compressibility (cm ³)	3.67 a ± 0.53	3.56 a ± 0.24	4.56 a ± 0.67
Color of crumb^c			
L value	64.6 a ± 0.1	58.5 b ± 1.0	62.3 c ± 0.3
a _L value	3.9 a ± 0.3	4.3 a ± 0.6	4.2 a ± 0.2
b _L value	16.0 a ± 0.2	15.8 a ± 0.3	16.4 a ± 0.5

^aMeans and standard deviations are based on four replications; means followed by the same letter showed no significant difference ($P < 0.05$).

^bFlour weight basis.

^cL values for lightness, a_L values for redness, b_L values for yellowness.

control.

The addition of navy bean hulls darkened the crumb color of cakes. Cakes prepared with the unroasted hulls were significantly darker than either the control or cakes made with roasted hulls; cakes prepared with roasted hulls were significantly darker than the control. The unheated hulls were slightly gray and imparted this darkness to cakes. The roasted hulls were yellow; consequently, cakes prepared with them were the most yellow; however, differences were not significant. Redness of the cakes did not differ significantly because of hull substitution.

Sensory analyses (Table III) indicated that flavor and general acceptability of the cakes prepared with unheated bean hulls were significantly less desirable than the control; however, they were still rated as moderately desirable. For all sensory characteristics, cakes prepared with the roasted hulls were scored higher than the cakes prepared with unheated hulls and were closer to values given to the control cakes.

Both the unheated and roasted navy bean hulls are high in dietary fiber—43 and 40%, respectively, based on enzyme neutral detergent fiber determinations.⁴ Wheat bran has been reported to contain about 39% dietary fiber (Shafer and Zabik 1978).

Few differences were attributed to roasting of the navy bean hulls; however, color of the hulls improved with heat treatment.

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TABLE III
Results from Sensory Analyses^a of Spice-Flavored Layer Cake Prepared with Unheated and Roasted Navy Bean Hulls

Sensory Characteristic ^b	Control	15% Substitution ^c	
		Unheated Hulls	Roasted Hulls
Color	8.8 a ± 0.2	7.9 a ± 0.2	8.4 a ± 0.8
Moistness	8.3 a ± 0.6	7.5 a ± 0.2	8.4 a ± 1.0
Tenderness	9.0 a ± 0.3	7.8 a ± 0.5	7.9 a ± 1.1
Texture	8.9 a ± 0.4	7.6 b ± 0.4	8.1 ab ± 0.8
Flavor	8.3 a ± 0.7	7.0 a ± 1.1	7.1 a ± 0.9
General acceptability	8.5 a ± 0.4	7.1 b ± 0.6	7.7 ab ± 0.8

^aMeans and standard deviations are based on four replications; means followed by the same letter showed no significant difference ($P < 0.05$).

^bRanked on a scale of 1 to 10 (1–2 = very undesirable; 3–5 = slightly desirable; 6–8 = moderately desirable; 9–10 = very desirable).

^cFlour weight basis.

Cakes prepared with either unheated or roasted bean hulls compared favorably to the control. Consequently, navy bean hulls are an acceptable source of dietary fiber in a flavored cake. More research should be initiated to investigate alternative uses for navy bean hulls as a dietary fiber source.

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