NOTE

Dry Roasted Navy Bean Flour Incorporation in a Quick Bread[1]

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Decline in dry bean consumption in the United States has prompted investigation into the use of bean ingredients in food systems. Some of the previous drawbacks to navy bean use have been long cooking time and indigestibility. Through roasting, grinding, and dehulling of the beans, cooking time is reduced, and digestibility is increased (Satterlee et al 1975). Several products can be obtained from navy beans, including various flours and protein isolates. In societies in which dietary protein is a critical issue, legumes are successful in increasing the quality of protein through complementation and through increasing total protein quantity. The use of quick breads is being considered by the U.S. School Breakfast Program. With this high protein formulation, a product with increased protein could be utilized. The use of navy beans has also included production of a shelf-stable flour for both home and commercial use (Anonymous 1979).

Previous research yielded legume breads and bread products with decreased flavor, volume, and color values (D'Appolonia 1978, Guadagni and Venstrom 1972, Satterlee et al 1975). The present research attempted to overcome these difficulties by producing a quick bread of high flavor intensity through the use of spices, consistent specific volume through the method of preparation, and decreased color change through the use of an already darkly colored product. Our objective was to compare the quality characteristics of pumpkin bread containing 0, 20, 35, and 50% navy bean flour substituted for wheat flour.

MATERIALS AND METHODS

Whole navy bean flour containing 25.5% protein was used. The flour was prepared from navy beans roasted at 270°C bead temperature, with a 1:15 bean-to-bead ratio and a 2 min residence time. The final bean temperature attained during roasting was 125°C. Processing details are given by Aguilera et al (1982). All other ingredients were obtained from commercial sources. Ingredients were weighed to the nearest 0.01 g and prepared by AACC method 10-90 (1976). The pumpkin bread formula (Rombauer and Becker 1978) consisted of the following ingredients: all-purpose or composite flour (100.65 g), sodium aluminum sulfate (SAS) baking powder (0.45 g), baking soda (2.00 g), salt (3.00 g), cinnamon (0.50 g), ground cloves (0.25 g), brown sugar (133.35 g), shortening (31.35 g), whole eggs (50.00 g), canned pumpkin (123.00 g), whole fluid milk (60.50 g), and vanilla (1.25 g). The composite flours consisted of wheat and navy bean flour blended in 80:20, 65:35, and 50:50 ratios, respectively. Batter samples (325 g) were poured into a greased 3 × 5-in. loaf pan prelined with waxed paper. Four replications of each variable were baked in an Etco forced convection oven at 177 ± 2°C for 45 min. Breads were removed and allowed to cool 5 min, then removed from the pan for further cooling.

Specific gravity, viscosity (Brookfield viscometer), and pH (Zeromatic pH meter) measurements were determined for the batter. Bread volume was measured by rapeseed displacement. Loaves were then sliced for further objective and sensory evaluations. Tenderness was determined with the standard shear compression cell of the Allo Kramer shear press using a 300-lb transducer and is reported as pounds per gram. Moisture of the pumpkin breads was determined by drying a 2-g shredded sample for 6 hr at 90°C under vacuum. Color parameters were determined using a Hunter color difference meter, model D25-2, standardized with a white tile ($L = 91.04$, $a_L = 1.0$, $b_L = 0.9$). A tasting panel of five trained members scored each of the samples using a descriptive score card; optimum characteristics were given a score of seven. Tasting was conducted in individual booths equipped with controlled light.

The data were analyzed for variance, and Duncan's new multiple range test (1957) was used to distinguish significant differences.

RESULTS AND DISCUSSION

Batter viscosity, specific gravity, and pH for all levels of navy bean incorporation were similar (Table I). Color of the bread was darker (decreased L value), less red (decreased a_L value), and less yellow (decreased b_L value) with increasing levels of navy bean flour substitution. Although significant differences in yellowness and redness occurred for each level of navy bean flour substitution, lightness values differed only between the control and the pumpkin bread substituted with 50% navy bean flour. Moisture content of the baked products, however, did not differ significantly (Table I). Volume of the quick breads decreased with increasing levels of navy bean flour substitution, with differences most significant between the control and bread with 50% navy bean flour. Pumpkin bread tenderness increased with increasing amounts of bean flour substitution; however, no statistical differences were found.

Odor, color, and tenderness of the pumpkin breads were not affected by navy bean flour substitution (Table II). Texture scores for pumpkin bread with the 35% level of navy bean flour substitution were superior to those of the control. Moistness of the bread with 50% navy bean flour was significantly lower than the other bread variables. Flavor scores decreased with increasing levels of substitution; however, a statistical difference was noted only between the control and the bread with the 50% level of navy bean flour substitution. Moreover, all pumpkin breads were of good quality, scoring above five on a seven-point scale; however, the pumpkin bread containing 35% navy bean protein substitution appeared to be optimum.

Legumes constitute an important source of protein for a large segment of the world's population. The quality of navy bean protein is limited by the amino acids it contains and the digestibility of the bean protein. The limiting amino acids are the essential sulfur-containing amino acids (Antunes et al 1979, Boloorforooshan and Markakis 1979, Evans and Bandemer 1967, Patel et al 1980). The legumes have a high lysine content (Boloorforooshan and Markakis 1979, Patel et al 1980), which makes them an excellent complement to cereal proteins. Protein contents of the pumpkin breads were 5.0, 5.6, 6.2, and 6.7% for loaves that had 0, 20, 35, and 50% have bean flour substituted, respectively.

A major drawback to using legumes as a protein food source is the low digestibility of the beans and the presence of antinutritional factors. Dry roasting the beans before producing navy bean flour reduces the antinutritional factors (Aguilera et al 1982).

Quick breads are unique baked products in that they encompass some of the functional qualities of both bread and cake. The products are baked as breads, yet they lack a strong gluten

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TABLE I
Physical Characteristics of Pumpkin Bread[a]

Characteristics[a]	Navy Bean Flour Substitution (%) 0	20	35	50
Batter				
Viscosity (centipoise)	835 a ± 53	825 a ± 124	855 ± 83	900 a ± 99
Specific gravity[b]	1.01 a ± 0.04	1.07 a ± 0.04	1.09 a ± 0.04	1.07 a ± 0.04
pH	7.13	7.00	6.95	6.73
Bread				
Hunter color difference				
L (lightness)	37.29 a ± 1.50	36.25 ab ± 1.86	34.60 ab ± 2.19	34.04 b ± 1.85
a_L (redness)	13.48 a ± 0.55	12.70 b ± 1.26	12.35 c ± 0.44	12.10 d ± 0.26
b_L (yellowness)	20.03 a ± 1.53	18.40 a ± 1.43	16.35 b ± 1.54	15.80 b ± 0.64
Moisture (%)	62.20 a ± 4.62	58.45 a ± 3.51	60.63 a ± 0.76	60.13 a ± 1.26
Tenderness (lb/g)	1.32 a ± 0.47	1.16 a ± 0.37	1.07 a ± 0.35	0.97 a ± 0.37
Volume (c^3)	600.0 a ± 23.7	587.5 ab ± 24.8	582.5 ab ± 17.6	561.3 b ± 18.4

[a] Means and standard deviation of the mean for four replications; means within a row followed by same letter indicate $P<0.05$ (Duncan 1957).
[b] Means and standard deviation of the mean for three replications.

TABLE II
Sensory Scores of Pumpkin Bread

Characteristics[a]	Navy Bean Flour Substitution (%) 0	20	35	50
Color	6.1 a ± 0.6	6.2 a ± 0.5	6.1 a ± 0.2	6.0 a ± 0.4
Texture	5.1 a ± 0.5	5.3 ab ± 0.3	6.1 b ± 0.6	5.3 ab ± 0.7
Tenderness	6.4 a ± 0.2	6.4 a ± 0.4	6.3 a ± 0.4	6.0 a ± 0.3
Moisture	6.2 a ± 0.6	6.1 a ± 0.1	6.1 a ± 0.1	5.5 b ± 0.3
Odor	5.6 a ± 0.4	5.5 a ± 0.5	5.6 a ± 0.4	5.0 a ± 0.5
Flavor	6.2 a ± 0.4	6.1 ab ± 0.6	5.7 ab ± 0.3	5.3 b ± 0.6

[a] Means and standard deviation of the mean based on four replications. Seven-point scale: 7 = optimum, 1 = poor. Means followed by same letter indicate $P<0.05$ (Duncan 1957).

development and contain a high ratio of sugar to flour, as in a cake system. Thus, incorporation of protein substitutes is feasible. The results of the study agreed with findings of other researchers. Tenderness values increased because of the reduced gluten formation and of the diluted nature of the gluten. Volume decreased because of decreased gluten formation. The product was darker because of increased reducing sugars in the navy bean flour, promoting the Maillard browning reaction. Nevertheless, a high-quality pumpkin bread was produced with navy bean flour substituted for 35% of the flour. This bread contained about 25% more protein than the control.

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