

# Color Influences Consumer Opinions of Wheat Muffins

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## ABSTRACT

Increased availability of white whole wheat has raised questions about consumer acceptance of products made with light-colored flour. Four types of miniature muffins were baked, each using traditional (red) whole wheat, white whole wheat, all-purpose, and caramel-colored all-purpose flours. Sixty-six volunteers evaluated the muffins for acceptability of color, appearance, flavor, texture, and overall quality using a 9-point hedonic scale and rated the healthiness of the products using a 10-point scale. The volunteers were then provided with information about the type of flour used in each sample and each type of muffin was rerated for overall acceptability and healthiness. No differences were found in acceptability of any attribute among muffin types. Healthy ratings were significantly different, with red whole wheat muffins having the highest rating, followed by white whole wheat, colored all-purpose, and all-purpose flour muffins. Overall acceptability decreased significantly for the all-purpose flour muffins after revelation of their content. Healthy ratings for white whole wheat increased the most after provision of the content information, while ratings decreased for muffins made with all-purpose flours. Improved nutrition education programs may be needed to inform consumers about selection of whole grain products.

Numerous nonprofit and government organizations promote the consumption of whole grains. The 2005 Dietary Guidelines for Americans recommend that three or more servings of whole grain foods be consumed daily to reduce risks for chronic diseases, yet only 11% of total grain servings were whole grains in the 1999-2002 United States National Health and Nutrition Examination Survey (NHANES) (2). Several reasons for low consumption of whole grain foods include difficulty identifying whole grain products, cost, perceived poor taste, time-intensive preparation, and limited product availability (1). Confusion exists among health professionals as well. A survey of dietitians in the United States revealed that only 60% of respondents could correctly identify a whole grain food and 42% did not know that a recommendation for whole grains consumption existed (3).

Approval of a health claim for whole grains and widespread introduction of whole grain products, including those made with white wheat should help to increase consumption of whole grains (6). The objectives of this pilot study were to determine whether product color affects acceptability and perceived healthiness of wheat muffins by consumers and to assess how providing information on flour composition (whole wheat or all-purpose) influences consumer opinions of those traits.

## MATERIALS AND METHODS

King Arthur traditional whole (hard red spring wheat, 14% protein, and 1.8% ash),

hard white spring whole (14% protein, 1.80% ash), and unbleached all-purpose hard red spring wheat flours (11.7% protein, 0.48% ash) (Norwich, VT), granulated sucrose (Hannaford, Scarborough, ME), brown large grade A eggs (Hannaford), 1% fat milk (Hannaford), butter (Hannaford), non-iodized salt (Morton's, Chicago, IL), Clabber Girl double action baking powder (Terre Haute, IN), and caramel powder (D. D. Williamson & Co., Inc., Louisville, KY) were purchased locally.

## Muffin Preparation

Aluminum mini-muffin pans (12 muffins per pan, each with 25-mL capacity; Wearever Co., Lancaster, OH), were sprayed with Pam (ConAgra Foods, Inc., Omaha, NE). Butter and sugar were creamed together in a KitchenAid Model 5 SS mixer (St. Joseph, MI) on lowest speed for 2 min. Eggs were added individually to the mixer bowl until well mixed. Other dry ingredients were sifted together in a separate bowl and then added to the mixer bowl. Milk was added gradually and stirred by hand. Batter was portioned with a No. 40 (25-mL) scoop and leveled in the pan with a knife. Muffins were baked in a preheated Blodgett BC14-E Combi oven (Burlington, VT) at 185°C for 9 min. Muffins were removed immediately from the pans, cooled on a wire tray, and then stored at room temperature in a plastic tote. Each batch (Table I) yielded 24

Table I. Wheat muffin formulations

Ingredient	Muffin Formulations			
	Red Whole Wheat	White Whole Wheat	All-Purpose	All-Purpose with Color
Unsalted butter	113 g	113 g	113 g	113 g
Sugar	134 g	134 g	134 g	134 g
Large eggs	100 g	100 g	100 g	100 g
Baking powder	9.2 g	9.2 g	9.2 g	9.2 g
Salt, non-iodized	1.5 g	1.5 g	1.5 g	1.5 g
Red whole wheat flour	240 g	—	—	—
White whole wheat flour	—	240 g	—	—
All-purpose flour	—	—	250 g	250 g
Caramel color	—	—	—	25 g
Lowfat milk	165 g	165 g	165 g	165 g

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muffins, and each formulation was prepared four times the day before sensory evaluation. Each of the four batches for each muffin type was comingled for color and sensory evaluations.

### Color Evaluation

Three muffins of each type were split in half vertically, and the color of the interior crumb of three halves was measured with a Hunter Labscan using the Commission Internationale d' Eclairage (CIE) Lab Scale. Three readings per sample were averaged. "L", "a", and "b" values were measured using a HunterLab Labscan XE 0/45 Spectrophotometer (Hunter Associate Laboratory Inc., Reston, VA) that Labscan calibrated using black and white color tiles supplied by the equipment manufacturer.

### Sensory Evaluation

The test protocol was approved by the University of Maine College of Natural Sciences, Forestry and Agriculture Committee for the Protection of Human Subjects. Subjects who were at least 18 years of age were recruited by flyers and postings on the University's First Class electronic communication platform (Richmond Hill, Ontario, Canada) to evaluate wheat muffins. Persons with allergies to any of the ingredients were advised to not participate in the study.

Evaluations were conducted in the Consumer Testing Center that is equipped with 12 individual workstations, each with a flat-panel monitor and computer linked to a server housing the Sensory SIMS 2000 information management system (Sensory Computer Systems, Morristown, NJ). Subjects were first asked to provide demographic information. The order of presentation of muffin types were randomized and balanced by the SIMS program. Subjects were asked to drink some spring water before tasting each sample. Each muffin was evaluated for color, appearance, texture, flavor, and overall acceptability using a 9-point hedonic scale (1 = dislike extremely; 5 = neither like nor dislike; 9 = like extremely) (7). Subjects were also asked to mark on a line scale how healthy they perceived the muffin sample to be. A line scale with verbal markers at either end was used (0 = not healthy at all; 10 = extremely healthy). After each muffin type had been evaluated with no identification other than a three-digit code, the sample muffins types were served again to subjects. Muffins made with either type of whole wheat flour were presented with a different code and labeled as "made with whole wheat flour." The muffins made with all-purpose flour were labeled as "made with all-purpose flour," and the colored muffins were labeled as "made with all-purpose flour with added caramel coloring." Overall acceptability was again rated for each muffin type, and subjects were asked to indicate how

healthy they thought the muffins were. Subjects were not permitted to view their previous ratings.

### Statistics

Data were analyzed with SYSTAT, version 11.0 using the GLM procure. Muffin type was the sole factor used for color analysis and most sensory attributes; overall acceptability and perceived healthiness were compared by muffin type and availability of formulation information. Means were compared with Fisher's Least Significant Difference (LSD) test with a significance level of 0.05 or less.

## RESULTS AND DISCUSSION

### Color

Muffins made with red whole wheat were significantly darker, redder, and less yellow than other muffin types (Table II). No differences in any color values were found between the white whole wheat muffins and the colored all-purpose muffins. Hamburger muffins made with white wheat were lighter in color than those made with red wheat (5).

### Acceptability

Sixty-six persons participated in the sensory evaluation of the muffins. Sixty-eight per cent of the panelists were female; 54.5% were aged 18–30 years, 23% were aged 31–48 years, and the rest of the panelists were between the ages of 49 and 60 years. All muffin types received acceptable mean scores that were greater than six (equivalent to like slightly); no differences in acceptability were found for most attributes (Table III). Overall acceptability scores were not different among samples before ingredient information was provided (Table IV). The mean overall acceptability for the colored muffins was significantly less than that for the red whole wheat muffins after information was provided.

Consumer opinions of how healthful a food might be have not been studied extensively. Although the muffins in this study contained saturated fat and refined sugar, the red whole wheat muffins still received fairly high scores (~7). Provision of flour information did not significantly change healthy ratings for those muffins. White whole wheat muffins were initially rated as less healthy than the red ones, but scores increased after information was

**Table II. Hunter color values for wheat muffins made with different types of flour<sup>a</sup>**

Muffin Type	Commission Internationale d' Eclairage (CIE) Color		
	L	a	b
Red whole wheat	55.70 ± 0.35 a	7.01 ± 0.10 d	23.79 ± 0.09 a
White whole wheat	64.57 ± 1.98 b	5.24 ± 0.04 b	29.38 ± 0.50 b
All-purpose	75.10 ± 0.65 c	0.65 ± 0.01 a	30.44 ± 0.43 b
Colored all-purpose	62.70 ± 1.21 b	6.07 ± 0.07 c	28.38 ± 2.12 b

<sup>a</sup> Means ± standard deviations (*N* = 3) followed by different letters are significantly different (Fisher's LSD test, *P* = 0.05).

**Table III. Acceptability of wheat muffins<sup>a</sup>**

Muffin Type	Color	Appearance	Texture	Flavor
Red whole wheat	6.8 ± 1.6	6.9 ± 1.4	6.6 ± 1.6	6.9 ± 1.5
White whole wheat	7.1 ± 1.0	7.1 ± 0.9	6.4 ± 1.5	6.6 ± 1.5
All-purpose	6.8 ± 1.5	6.7 ± 1.4	6.7 ± 1.5	6.7 ± 1.4
Colored all-purpose	7.2 ± 1.2	7.0 ± 1.4	6.6 ± 1.4	6.7 ± 1.6

<sup>a</sup> Nine-point hedonic scale (1 = dislike extremely; 5 = neither like nor dislike; 9 = like extremely).

**Table IV. Overall acceptability and healthy ratings of wheat muffins without and with ingredient information<sup>a</sup>**

Muffin Type	Ingredient Information		Overall Acceptability <sup>b</sup>	Healthy Rating <sup>c</sup>
	Provided			
Red whole wheat	no		6.9 ± 1.4 bc	6.9 ± 1.7 d
	yes		7.1 ± 1.3 c	7.2 ± 1.6 d
White whole wheat	no		6.6 ± 1.3 a	6.2 ± 1.7 c
	yes		6.7 ± 1.4 abc	7.0 ± 1.7 d
All-purpose	no		6.6 ± 1.4 a	4.7 ± 1.8 ab
	yes		6.4 ± 1.5 a	4.1 ± 1.6 a
Colored all-purpose	no		6.8 ± 1.4 abc	5.1 ± 1.7 b
	yes		6.5 ± 1.5 a	4.2 ± 1.7 a

<sup>a</sup> Means ± standard deviations within columns followed by different letters are significantly different (Fisher's LSD test, *P* = 0.05).

<sup>b</sup> Nine-point hedonic scale (1 = dislike extremely; 5 = neither like nor dislike; 9 = like extremely).

<sup>c</sup> Line scale with verbal anchors at each end (0 = not healthy at all; 10 = extremely healthy).

provided. Both types of muffins containing all-purpose flour received lower healthy ratings than did the whole wheat muffins, suggesting that factors other than overall color may influence consumer attitudes. Flour information has no significant impact on the healthy ratings for the all-purpose flour muffins, but scores significantly declined for the colored muffins (5.1 to 4.2).

A survey of Belgian consumers revealed that belief in the efficacy of a functional food, knowledge, and presence of an ill family member were more influential factors than common socio-economic factors in predicting acceptance of functional foods (8). Consumers prefer short, succinct wording for nutrition claims (9). Although none of the muffin formulations met the U.S. standard of 51% whole grain by weight to bear a whole grain claim (4), the knowledge that some muffins contained whole wheat flour clearly influenced the opinions of

participants in the study. The findings of this pilot study suggest that consumer education and marketing campaigns to promote whole grain consumption should focus on identification of whole grain content rather than product color.

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