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Sensory Evaluation Ratings and Moisture Contents Show that Soy Is Acceptable as a Partial Replacement for All-Purpose Wheat Flour in Peanut Butter Graham Crackers

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ABSTRACT

Fortification can help individuals achieve adequate nutritional intake. Foods may be fortified with soy flour as a source of protein for individuals limiting their intake of animal products, either due to personal dietary preference or to reduce their intake of saturated fat, a known risk factor for heart disease. This study determined the feasibility of fortifying peanut butter graham crackers by substituting soy flour for all-purpose wheat flour at 25%, 50%, 75%, or 100% weight/weight. Graham crackers fortified with soy flour were compared to similarly prepared nonfortified peanut butter graham crackers. Moisture contents of all graham crackers were similar. Consumers ($n=102$) evaluated each graham cracker using a hedonic scale and reported liking the color, smell, and texture of all products. However, unlike peanut butter graham crackers fortified with lower levels of soy, graham crackers fortified with 100% weight/weight soy flour had less than desirable flavor, aftertaste, and overall acceptability. Overall, this study shows that fortification of peanut butter graham crackers up to 75% weight/weight with soy flour for all-purpose wheat flour is acceptable.

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Emerging evidence is defining a role for soy in health and disease. Soy contains isoflavones and protein, which may play roles in reducing chronic disease (1-4). Epidemiologic data show an inverse relationship between soy consumption and risk of coronary heart disease (5) and some forms of cancer (6). In addition, soy is an excellent source of plant protein and low in saturated fat (7). Because high levels of dietary fat, in particular saturated fat, are known risk factors for heart disease (8), consumption of soy rather than animal products for protein may contribute to the observed inverse relationship between soy and coronary heart disease (5).

In an effort to promote increased consumption of soy, several studies have successfully fortified grain-based products with soy flour. Specifically, Yeu and colleagues (9) created a wheat-based extruded cereal that was acceptable with up to 54% weight/weight (w/w) fortification with soy flour. Similarly, Shogren and colleagues (10) reported acceptable sensory characteristics following fortification of wheat-based spaghetti with up to 35% w/w soy flour. However, Mashayekh and colleagues (11) were only able to fortify wheat bread with up to 7% w/w soy flour before decreases in sensory characteristics were noted. Maximal levels of acceptability in these soy-based grain products may have been reached because soy replacement of wheat flour results in products with added protein but reduced gluten thereby giving the final products negative characteristics of firmer texture and decreased volume (12,13). Despite successes in fortifying these types of products with varying levels of soy, no one to date has fortified graham crackers with soy.

Because soy is considered to be strongly flavored (14), the addition of an even stronger flavored ingredient to a soy-fortified, grain-based product may be warranted to help mask any undesirable flavor soy may contribute to the product when present in higher quantities. Commercially available products, such as high protein bars, often contain stronger flavored ingredients such as peanut butter, chocolate, or lemon when the products contain soy (15,16).

The objective of this study was to determine the feasibility of fortifying peanut butter graham crackers with soy flour. The qualities of fortified graham crackers were compared to an unfortified peanut butter graham cracker by analysis of percent moisture and consumer acceptability of sensory characteristics.

Table 1. Formulas, preparation procedures, and nutrient compositions for peanut butter graham crackers used to test acceptability of replacing none, all, or a portion of all-purpose wheat flour with soy flour^a

	% Replacement with Soy				
	0% ^c	25%	50%	75%	100%
Ingredient^b (% weight/weight of total 546.7-g recipe)					
Dark brown sugar (%)	20.1	20.1	20.1	20.1	20.1
Granulated cane sugar (%)	9.2	9.2	9.2	9.2	9.2
Creamy peanut butter ^d (%)	14.6	14.6	14.6	14.6	14.6
Honey (%)	0.6	0.6	0.6	0.6	0.6
Vegetable shortening (%)	7.0	7.0	7.0	7.0	7.0
Almond extract (%)	0.1	0.1	0.1	0.1	0.1
Vanilla extract (%)	0.1	0.1	0.1	0.1	0.1
All-purpose wheat flour (%)	11.4	8.6	5.7	2.8	0.0
Soy flour (%)	0.0	2.8	5.7	8.6	11.4
Whole-wheat graham flour (%)	22.0	22.0	22.0	22.0	22.0
Baking powder (%)	0.4	0.4	0.4	0.4	0.4
Baking soda (%)	0.2	0.2	0.2	0.2	0.2
Salt (%)	0.2	0.2	0.2	0.2	0.2
1% fat milk (%)	14.1	14.1	14.1	14.1	14.1
Nutrient content per serving (28 g)^e					
Energy (kcal)	130.7	130.4	130.3	130.0	129.2
Fat (g)	5.0	5.0	5.0	5.0	4.9
Saturated fat (g)	1.0	1.0	1.0	1.0	1.0
Energy from fat (%)	34.4	34.5	34.5	34.6	34.1
Cholesterol (mg)	0.2	0.2	0.2	0.2	0.2
Sodium (mg)	67.3	67.4	67.5	67.6	67.7
Carbohydrates (g)	19.1	18.6	18.1	17.8	17.4
Protein (g)	2.4	2.8	3.2	3.5	3.9
Dietary fiber (g)	1.4	1.5	1.7	1.8	2.0
^a Procedure for preparing graham crackers with all-purpose wheat flour and partial or complete replacement with soy flour: In a KitchenAid Mixer (Model KSM90, Kitchen Aid USA, St Joseph, MI) equipped with a wire whip, cream sugars, peanut butter, honey, and shortening until fluffy on Speed 4 for 1 min. Scrape the sides of the bowl. Continue creaming for another 4 mins. Add the almond extract and vanilla. Cream on Speed 4 for 1 min. In a separate bowl, sift flour, baking powder, baking soda, and salt. Add sifted dry ingredient mixture alternately with milk in four steps to creamed mixture, blending with the flat beater attachment (Speed 4, 1 min) after each addition. Chill the dough at -94°F (-70°C) for 5 min. Turn dough out on a floured board. Roll 0.32 cm thick. Cut into 5-cm×5-cm squares using a pizza cutter. Place 2.5 cm apart on an ungreased, nonstick 28-cm×43-cm cookie sheet. Bake 350°F (177°C) for 9.5 min. Immediately remove from pan, cool completely on a wire rack, and store in an airtight container. ^b Ingredients for graham crackers, including sugars, peanut butter, honey, shortening, almond and vanilla extracts, all-purpose wheat flour, baking powder, baking soda, salt, 1% fat milk (Great Value, Wal-Mart Inc, Bentonville, AK) and soy flour and whole wheat graham flour (Hodgson Mill, Effingham, IL) were obtained from a local supermarket. ^c Plain peanut butter graham cracker (unpublished data, May 2007). ^d Nutrient composition (per standard 32-g serving) of peanut butter used in this study: 180 kcal, 7 g protein, 15 g fat, 2 g saturated fat, 8 g total carbohydrate, 3 g sugar, 2 g fiber. ^e The nutrition content of each product was calculated manually utilizing data from the US Department of Agriculture, Agricultural Research Service Nutrient Database for Standard Reference, Release 23 (7).					

METHODS

Preparation of Graham Crackers

Peanut butter graham crackers, developed in an undergraduate experimental food science course by one of the authors, served as the control for this study. Soy flour was then substituted for 25%, 50%, 75%, or 100% all-purpose wheat flour in the control recipe. Ingredients common to each peanut butter graham cracker recipe included dark brown sugar (110.0 g), granulated cane sugar (50.0 g), peanut butter (80.0 g), honey (3.5 g), vegetable shortening (38.5 g), almond extract (0.5 g), vanilla extract (0.5 g), whole-wheat graham flour (120.0 g), baking powder (2.3 g), baking soda (1.2 g), salt (0.8 g), and 1% fat milk (76.9 g). All-purpose wheat flour (62.5 g, 46.9 g, 31.3 g, 15.6 g, or 0.0 g) and soy flour (0.0 g, 15.6 g, 31.3 g, 46.9 g, or 62.5 g), were also included in the 0%, 25%, 50%, 75%, and 100% replace-

ment with soy flour formulas, respectively. Formulas for control and soy-containing peanut butter graham crackers are presented in Table 1 as percentages w/w. To be comparable to other commercially available graham cracker products, a serving size of graham crackers was determined to be 28 g (7).

Nutritional Composition

The nutrition content of each peanut butter graham cracker was calculated on an electronic spreadsheet (Microsoft Office Excel, 2003, Microsoft Corporation, Redmond, WA) utilizing data from the US Department of Agriculture, Agricultural Research Service Nutrient Database for Standard Reference, Release 23 (7). For comparison, the nutrition content of commercially available graham crackers was similarly calculated.

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