

Formulation and Evaluation of Snack Crackers Made with Peanut Flour

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ABSTRACT

Baked snack crackers were successfully created with a flour mixture containing peanut, wheat, and rice flours. The following flavors were evaluated in the product: cheddar cheese, garlic, blackened Cajun, and Italian. These varieties, as well as five popular commercial wheat-based crackers, were all compared with an unflavored peanut flour cracker (control) via nutritional analysis and instrumental measurements of color and texture properties. Sensory evaluation of peanut flour cracker varieties was conducted to determine consumer acceptability. Results show that peanut flour crackers were higher in protein and dietary fiber and lower in total carbohydrate content than the commercial crackers. Color values for peanut flour crackers were significantly affected by the addition of flavored powders, but the color of the basic peanut flour cracker was similar to the commercial crackers in the study. Texture evaluation determined that the peanut flour crackers were consistently softer than the commercial crackers. Sensory evaluation determined that the cheddar cheese-flavored peanut flour crackers were liked best by consumers, as indicated by high hedonic ratings. All other varieties were rated favorably except for those with Italian seasoning, which were slightly disliked. Overall, a cracker made with peanut flour is a promising consumer product with enhanced nutrition.

The peanut is a valuable seed from the legume *Arachis hypogaea*, which is largely produced in India, China, and the United States for human consumption as a whole seed, extracted oil, peanut butter, or protein-enhancing ingredient. Worldwide, peanuts are mostly used to produce high-quality edible oil. In the United States, the majority of the crop is consumed in whole seed form or used for peanut butter production (3). A small fraction of U.S. peanuts is pressed for oil production. Hydraulic or screw presses can expel 85–95% of the oil from crushed peanut seeds (2). Processors then use the remaining defatted “cake” to make peanut grits, meals, flours, and protein concentrates (12), all of which are potential food ingredients with high nutrient density.

Despite the high caloric content of peanuts, studies have shown that peanuts can be very beneficial in the diet. Peanuts are

abundant in B-vitamins, magnesium, folate, vitamin E, copper, phosphorus, unsaturated fatty acids, protein, and dietary fiber. Adequate levels of both vitamin E and magnesium are particularly crucial for inclusion in the diet, as they support good heart health (9). Consumption of peanuts has also been shown to reduce the chances of cholecystectomy (gallstone disease) in women (20). In recent decades, peanuts have received much attention as effective protein supplements for cereal grains. The peanut’s amino acid profile is considerably better than that of many grains, such as wheat or corn, and can be used to improve the quality of protein consumed in grain-based vegetarian diets, reducing the prevalence of protein energy malnutrition (PEM) (17).

PEM has been a huge problem in developing countries, since foods with high-quality protein are not widely available. Numerous studies have demonstrated the effectiveness of cereal-legume combinations. For example, Bressani et al. (5) found that blending corn with black beans caused increased growth response in rats compared with corn or black beans alone, indicating higher protein quality. Ingbian and Adegoko (10) found that groundnuts and soybeans were good supplements for corn maize and were capable of increasing growth in rats. Baptist and DeMel (4) found that diets devoid of animal protein

can be equally healthy for proper growth in children when composed of cereal and legume protein combinations. One study conducted by Johns and Finks (11) found that supplementing wheat with 15–25% peanut flour would provide sufficient proportions of amino acids necessary for normal growth in rats.

Defatted peanut products, such as meals or flours, are particularly effective for protein fortification due to their high protein concentration. Defatted peanuts can contain up to 65% protein, depending on the extent of fat removal (18). Adding defatted peanuts to cereal grains can result in protein quality higher than that of either substance alone, yielding high-value food products. Peanut protein is most limited by its methionine content (16) but is a good source of lysine. Cereal grain protein (such as wheat), however, is most limited by its lysine content, while its methionine value is higher than that of peanut’s (1). When combined, the lysine from peanut flour supplements cereal grains; also, the methionine level of peanut protein is improved by methionine from cereal protein.

Defatted peanut flour, made by drying and grinding edible-grade peanut “cake,” has been the most common peanut ingredient in the creation of protein-enhanced products. Partially defatted peanut flours retain the characteristic peanut flavor. Fully defatted flour is produced by solvent extraction of partially defatted peanut cake; this process weakens the peanut taste and aroma (12). Peanut flours have been successfully incorporated into breads, breakfast cereals, cakes, cookies, snack foods, ice cream, and beverages (18). Ory and Conkerton (14) prepared acceptable breads, muffins, and cookies with peanut flour replacing up to 12.5, 100, and 50% of the wheat flour in these formulations, respectively. Prinyawiwatkul et al. (15) developed an extruded snack food using peanut flour and cornstarch. Suknark et al. (19) successfully produced an extruded half-product with 40% peanut flour supplementing tapioca flour. A puffed product with peanut and rice flours was also made via extrusion. Optimum peanut flour levels, as determined by consumer evaluation, were between 30 and 40% (6). Other no-

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table products that have utilized peanut flour include fried peanut chips (13), baked peanut chips (21), peanut-soy milk (8), and peanut-wheat Chinese noodles (7).

While many of these value-added products tend to be snack foods, peanut flour has not previously been used in crackers, which are almost a staple for snacks in the United States. Crackers are a popular snack choice due to their appealing flavors, light crispness, convenience, and shelf stability. As a baked product, crackers are perceived as a healthy snack option compared with oil-fried or sugar-filled alternatives. The addition of high-protein peanut ingredients would create an ideal snack with impressive nutrition. The use of peanuts in a similar product, baked chips, has been thoroughly studied. In research conducted by Zenere in 2003 (21), baked peanut chips were made from cold-pressed peanut flour at levels greater than 50% and were subjected to sensory evaluation. The evaluation indicated that the chip was unacceptably hard in texture, and suggestions called for a softer, more "cracker-like" product. Results from this evaluation, along with the vast potential market, inspired the creation of peanut flour crackers.

In this study, the objective was to determine the functionality and appropriate-use level of partially defatted peanut flour in a snack cracker formulation. The goal was to include as much peanut flour as possible, while maintaining good dough-handling properties and end-product acceptability. Sensory evaluation assessed consumer acceptability of a basic peanut flour cracker formulation (control) and four flavor-enhanced versions. The first part of this investigation sought to establish a working formula for peanut flour crackers with appropriate ingredients and ingredient-use levels. The latter part aimed to improve the original formulation, explore flavor options, determine nutritional information, measure physical properties, and assess consumer acceptability.

MATERIALS AND METHODS

Peanut flour crackers were prepared using a three-flour mixture of wheat (all purpose), rice, and peanut flours in accordance with a simple wheat cracker recipe. The proportions of the flour types in the formula were varied according to a three-component constrained simplex-lattice mixture design, yielding 10 different formula variations for initial evaluation (Table I). Other recipe ingredients initially included partially hydrogenated vegetable shortening (Crisco brand), whole milk, eggs, baking powder, and salt. All basic

ingredients were obtained from local grocers. Partially defatted, light roast peanut flour (12% fat, 50% protein) was obtained from Golden Peanut Company, Inc. (Alpharetta, GA, U.S.A.).

Processing steps included dough formation, sheeting, cutting, and baking. Dough preparation involved mixing the dry ingredients, cutting in the shortening, adding liquid ingredients, and mixing with a food processor (model 106622F; GE licensed to Wal-Mart Stores, Bentonville, AR, U.S.A.) on the lowest speed. Once the dough was formed, it was divided into 175-g balls, which were then fed twice through a sheeting device (model SDR-4; Anetsberger Brothers, Inc., Northbrook, IL, U.S.A.) for uniform flattening, first on setting six and then on setting one. The dough was then cut into small squares with a multiblade, standard strip cutter (Moline Machinery Ltd., Duluth, MN, U.S.A.) set at 25 mm. The squares were then pricked and lightly sprinkled with salt. Wire mesh band tunnel ovens are typically used by the industry to bake crackers, but since this type of oven was not available, an impingement oven (model 1452; Lincoln Foodservice Products, Inc., Fort Wayne, IN, U.S.A.) was used. Preliminary trials established that uniform browning could be achieved with the impingement oven by placing samples on perforated baking pans, covering with an additional perforated pan, and baking at 258°C for 2 min and 40 s. The dimensions of all baked crackers, as measured with a caliper, were as follows: length = 26.7 mm, width = 25.8 mm, and thickness = 1.9 mm.

The 10 experimental formulas from Table I were subjectively evaluated on dough-handling properties and baking quality. Of the samples with good handling and baking performance, the mixture with the highest peanut flour level was selected for further study. The mixture of choice consisted of 58% wheat flour, 17.5% rice flour, and 24.5% peanut flour.

In the second part of the study, the formula of choice (formula number 6 from Table I) was altered to improve texture and nutritional aspects. Modifications included the addition of pregelatinized, modified food starch (Baka-snak; National Starch and Chemical Co., Bridgewater, NJ, U.S.A.) for crispness; replacement of whole milk with nonfat milk; and replacement of shortening with its trans-fat-free version. In addition to the wheat/rice/peanut flour mixture, the modified cracker recipe contained 24% water, 10% trans-fat-free shortening, 4% whole egg, 1% salt, 2.7% dry milk, 0.3% baking powder, and 7% modified food starch. Seasoning powders were added to the control formula by mixing with other ingredients prior to baking; flavors included blackened Cajun seasoning (Givaudan Flavors Corp., Cincinnati, OH, U.S.A.), Italian seasoning (Kroger Co., Cincinnati, OH, U.S.A.), garlic powder (Kroger Co., Cincinnati, OH, U.S.A.), and cheddar cheese seasoning (McClancy Seasoning Co., Fort Mill, SC, U.S.A.). The use levels for these flavoring agents were as follows: Cajun (1.24%), Italian (1.0%), garlic (2.0%), and cheddar cheese (10.0%). The preparation of these modified crackers involved the same preparation method described above; however, baking time was slightly reduced (5 to 20 s) for the seasoned crackers to prevent overbrowning. Samples of the improved peanut flour cracker control and samples containing the different flavored powders were then subjected to nutritional analysis and instrumental tests for comparisons. The same tests were also performed on five varieties of commercial snack crackers (saltine, Wheat Thins, Wheatables, Wheatsworth, and Club).

Nutrient composition of the experimental peanut flour cracker samples was determined by Silliker Laboratories (Chicago Heights, IL, U.S.A.), using standard approved methods for baked goods. Analytical results satisfy requirements for nutrition labeling. Nutritional information was obtained for a 28-g serving size of each variety. Results were compared with the nutrition facts for the commercial crackers, which were obtained from the products' nutrition labels and converted to show nutrient content for 28-g serving sizes.

Instrumental color measurement for these samples was conducted with a HunterLab MiniScan XETM colorimeter (model 45/0-L; Hunter Associates Laboratory, Reston, VA, U.S.A.). Measurements were averaged from three replications using the lightness (L*) redness (a*) yellowness (b*) scale. Chroma, hue angle, and total color difference were also calculated from the data.

Table I. Composition of peanut flour cracker formulations in a three-component constrained simplex-lattice mixture design

Formula Number	Wheat Flour (%)	Rice Flour (%)	Peanut Flour (%)
1	93.00	0.00	7.00
2	58.00	35.00	7.00
3	58.00	0.00	42.00
4	75.50	17.50	7.00
5	75.50	0.00	24.50
6	58.00	17.50	24.50
7	69.67	11.67	18.67
8	81.33	5.83	12.83
9	63.83	23.33	12.83
10	63.83	5.83	30.33

Texture analysis was conducted as a "snap test" using an Instron Universal Testing Machine (model 5542; Instron Corporation, Canton, MA, U.S.A.), which was equipped with a Plexiglas probe (30° taper). Operating conditions for the Instron testing machine were as follows: crosshead speed = 10 mm/min, compression extension = 4 mm, and bridge distance = 15 mm. Twenty-five individual crackers of each variety were tested, and the results for force (Newtons) and energy (Joules) were averaged.

Sensory evaluation was conducted to determine consumer acceptance of unflavored peanut flour crackers and the four flavor variations (cheddar cheese, Cajun, garlic, and Italian). Seventy-five panelists were recruited from the local community (Griffin, GA, U.S.A.) and were screened to be at least 18 years old, eat crackers on a regular basis, and be free of allergies re-

lated to the ingredients in these crackers (peanut, wheat, milk, egg, salt, flavorings). The group of participants had the following demographic profile: ages 18–75, 80% females, 77% white, 59% married, 61% high school graduates, 43% full-time employees, and 53% with an annual income less than \$30,000.

The evaluation was conducted in the climate-controlled sensory laboratory at the University of Georgia, Griffin Campus. Panelists evaluated samples in partitioned booths illuminated with incandescent lighting. Product evaluation was based on a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely). Consumers used the scale to evaluate the crackers on the following attributes: appearance, color, aroma, flavor, texture, and overall liking. Samples were coded with random three-digit numbers and presented in a randomized order. Pan-

elists ate plain, unsalted wheat crackers between samples to cleanse their palates. After the evaluation, participants completed an exit questionnaire, which evaluated cracker purchasing, consumption, and handling practices. It also inquired about the person's willingness to buy nutrition-enhanced crackers. Panelists received a small honorarium (\$10.00) for their participation.

Statistical analysis was used to explain trends in the data. The general linear model (GLM) procedure was used to analyze all data on Statistical Analysis Software (SAS Institute 2001). Mean separation tests were performed by the least significant difference (LSD) test ($\alpha = 0.05$).

RESULTS AND DISCUSSION

The nutritional composition of peanut flour cracker varieties and similar com-

Table II. Nutritional composition of experimental peanut flour crackers and selected commercial crackers

Nutritional Component	Peanut Flour Crackers ^a					Commercial Crackers ^b				
	Unflavored Control	Cheddar Cheese	Blackened Cajun	Italian	Garlic	Saltine	Wheat Thins	Wheatables	Wheatsworth	Club
Calories	130	150	130	130	130	112	135	131	140	140
Calories from fat	45	90	45	45	45	19	45	47	61	50
Total fat (g)	5	10	5	5	5	3	5	6	6	6
Saturated fat (g)	1	1.5	1	1	1	0	1	1	1	1
Trans-fat (g)	0	0	0	0	0	0	0	0	0	0
Cholesterol (mg)	5	10	5	5	5	0	0	0	0	0
Sodium (mg)	220	640	390	230	169	355	253	280	298	270
Total carbohydrate (g)	16	11	16	16	16	21	19	19	18	18
Dietary fiber (g)	2	2	2	2	2	0	1	1	1	1
Sugars (g)	2	3	2	2	2	0	3	3	2	4
Protein (g)	5	4	5	5	5	2	3	2	4	2
Vitamin A (%) ^c	<2	2	<2	<2	<2	0	0	0	0	0
Vitamin C (%) ^c	N/A ^d	N/A ^d	N/A ^d	N/A ^d	N/A ^d	0	0	0	0	0
Calcium (%) ^c	4	4	2	4	<2	0	2	0	0	0
Iron (%) ^c	4	4	4	4	4	8	5	4	7	4

^a Values based on 28-g serving sizes and analyzed by Silliker Laboratories, Chicago Heights, IL, U.S.A.

^b Adapted from manufacturers' nutrition labels for 28-g serving sizes.

^c Percent daily value.

^d Not analyzed, as product is generally not considered a source of this nutrient.

Table III. Color characteristics of experimental peanut flour cracker varieties and selected commercial crackers^w

Cracker	Lightness (L*)	Redness (a*)	Yellowness (b*)	Chroma ^x	Hue Angle ^y	ΔE^z
Peanut Flour Crackers						
Unflavored control	67.56 a	6.95 bc	28.05 b	28.90 b	76.09 ab	0 b
Cheddar cheese	62.74 b	16.14 a	41.84 a	44.87 a	69.24 c	17.27 a
Blackened Cajun	63.48 b	10.87 b	30.99 b	32.84 b	70.68 c	6.38 b
Italian	63.95 b	5.46 c	28.20 b	28.76 b	79.04 a	4.15 b
Garlic	66.59 a	7.20 bc	28.12 b	29.03 b	75.63 b	1.02 b
Commercial Crackers						
Saltines	79.05	2.78	22.26	22.44	82.87	13.52
Wheat Thins	65.06	11.74	37.8	39.58	72.74	11.15
Wheatables	63.82	7.51	27.11	28.13	74.52	3.9
Wheatsworth	62.77	5.07	30.89	31.3	80.67	5.88
Club	62.91	8.32	29.19	30.35	74.08	4.98

^w Values followed by the same letter are not significantly different.

^x Calculated with the formula $(a^*2 + b^*2)^{1/2}$.

^y Calculated with the formula $[\tan^{-1}(b^*/a^*)]$.

^z Calculated with the formula $[(L^* - L^*\text{control})^2 + (a^* - a^*\text{control})^2 + (b^* - b^*\text{control})^2]^{1/2}$. Values for both peanut flour and commercial crackers were calculated in relation to the unflavored peanut flour cracker control, which was set at zero.

mercial products is shown in Table II. The peanut flour crackers with cheddar cheese flavor had 15% more calories, twice the fat, and considerably more sodium than the other peanut flour crackers. As a group, the peanut flour crackers contained more protein, less carbohydrate, more dietary fiber, and more cholesterol (per 28-g sample) than all of the commercial crackers. None of the crackers contained trans-fatty acids.

Instrumental color measurements of peanut flour crackers and commercial crackers are shown in Table III. Only the results for peanut flour crackers were used for statistical analysis. Chroma, hue angle, and total color difference (ΔE) were derived from instrumental values given for lightness (L^*), redness (a^*), and yellowness (b^*). Peanut flour crackers with cheddar cheese powder had the most saturated and intense color (chroma = 44.87) of all the peanut flour cracker varieties. The color of the cheddar cheese variety was also the most different from the unflavored control ($\Delta E = 17.27$). The uniqueness of the cheddar cheese variety was due to the higher redness value ($a^* = 16.14$) and higher yellowness value ($b^* = 41.84$) compared with the other samples. The unflavored control crackers and the garlic-flavored crackers were significantly lighter in color (L^* values = 67.56 and 66.59, respectively) than the other flavored peanut flour crackers. The unflavored control crackers and Italian-flavored crackers were significantly less brown (hue angle = 76.09 and 79.04, respectively) than crackers flavored with cheddar cheese or blackened Cajun seasoning (hue angle = 69.24 and 70.68, respectively). The brownness of the garlic-flavored crackers was not significantly different from the unflavored control. Compared with the commercial crackers, the color of the peanut flour

crackers was quite similar. The chroma values of the peanut flour crackers ranged from 28.76 to 44.87, while the chroma of commercial crackers ranged from 22.44 to 39.58. Hue angles ranged from 69.24 to 79.04 for peanut flour crackers and from 72.74 to 82.87 for the commercial samples. Of all experimental and commercial crackers, the sample with the greatest total color difference from the unflavored control was the cheddar cheese-flavored peanut flour cracker sample, which had a ΔE value of 17.27. The commercial sample with color most different from the control was that of the saltine crackers, with a ΔE value of 13.52. The saltine crackers were considerably lighter in color than the peanut flour crackers. The color of the other commercial crackers, however, was not very different from the unflavored peanut flour crackers. Crackers with color properties most like the unflavored control were the garlic-flavored peanut flour crackers and Wheatables, with ΔE values of 1.02 and 3.90, respectively. Overall, the factor that most significantly affected the color of the peanut flour crackers was the addition of cheddar cheese-flavored powder.

Instrumental texture measurements of the peanut flour crackers and commercial varieties are shown in Table IV. Only the peanut flour cracker varieties were included in the statistical analysis, in order to show the textural effect of using different flavored powders. The crackers with cheddar cheese flavor required significantly less force to snap (6.14 N) than the other peanut flour cracker varieties. In terms of work, the energy values exerted in snapping the unflavored control and the cheddar cheese- and garlic-flavored crackers were 0.95, 0.90, and 1.18 mJ, respectively, and were significantly less than energy values exerted in snapping the Cajun-flavored and Italian-flavored crackers, 1.48 and 1.50 mJ, respectively. Compared with the commercial crackers, the peanut flour crackers required much less force and less energy to snap. The peanut flour cracker samples, therefore, were much softer and more easily broken than the commercial crackers. The variation is likely due to differences in the ingredients

and manufacturing processes between the crackers made with peanut flour and the commercial crackers. Overall, the Cajun- and Italian-flavored crackers were closer in texture to the commercial crackers than the other varieties.

The average mean ratings from the sensory evaluation are shown in Table V. The peanut flour crackers with cheddar cheese flavor received the highest hedonic ratings (based on a 9-point scale) for appearance (7.2), color (7.2), aroma (6.7), flavor (6.7), and overall liking (6.7). These ratings indicate that this variety was liked at least moderately by panelists. The lowest ratings were given for the peanut flour crackers with Italian seasoning (appearance = 5.8, color = 5.9, aroma = 5.3, flavor = 4.6, and overall liking = 4.8). The rating of 4.8 for overall liking of the Italian-flavored variety indicates that consumers slightly disliked this cracker. The unflavored control crackers and those flavored with garlic powder and Cajun seasoning received intermediate ratings for overall liking (5.6 to 6.2). Since products with average hedonic ratings greater than 5.0 were considered acceptable, the ratings for these intermediate products indicate that they were acceptable. Overall, consumers liked all of the samples except for the crackers with Italian seasoning. The cheese-flavored peanut flour crackers, however, were clearly the favorite choice.

Cracker purchasing, consumption, handling, and willingness-to-buy characteristics of the participating consumers are shown in Table VI. The results of the survey show that more consumers purchased crackers less than once a week (63.9%) than on a weekly basis (34.7%). More of the consumers ate crackers on a weekly basis (47.2%) than on a daily basis (23.6%). Saltine crackers were purchased most frequently, followed by Wheat Thins and cheese crackers. Most consumers purchased crackers in the boxed form (75%). A majority of the consumers (77.8%) were concerned about the nutritional quality of crackers. Furthermore, 80.6% indicated a willingness to pay extra for crackers with enhanced nutrition, up to \$0.10 more per package.

Table IV. Texture characteristics of peanut flour cracker varieties and selected commercial crackers^z

Cracker	Breaking Force (N)	Energy (mJ)
Peanut Flour Crackers		
Unflavored control	7.21 a	0.95 b
Cheddar cheese	6.14 b	0.90 b
Blackened Cajun	7.94 a	1.50 a
Italian	7.79 a	1.48 a
Garlic	7.53 a	1.18 b
Commercial Crackers		
Saltines	13.62	9.09
Wheat Thins	13.79	1.92
Wheatables	11.51	2.03
Wheatsthworth	11.78	2.77
Club	8.44	1.69

^z Values followed by the same letter are not significantly different.

Table V. Mean ratings^y for consumer acceptance of peanut flour crackers^z

Sample	Appearance	Color	Aroma	Flavor	Texture	Overall Liking
Unflavored control	6.4 b	6.3 cd	5.7 cd	6.1 ab	6.7 a	6.2 ab
Cheddar cheese	7.2 a	7.2 a	6.7 a	6.7 a	6.9 a	6.7 a
Blackened Cajun	6.7 b	6.9 ab	6.3 ab	5.8 b	5.8 b	5.6 b
Italian	5.8 c	5.9 d	5.3 d	4.6 c	5.5 b	4.8 c
Garlic	6.6 b	6.4 bc	6.1 bc	6.0 b	6.5 a	6.0 b

^y On a 9-point scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely).

^z Ratings followed by different letters are not significantly different.

Staleness of flavor was the most frequent choice (87.5%) by consumers in deciding if crackers were no longer edible, followed by texture (too soft or too hard), which was selected by 66.7% of the panelists. Forty-three percent of the participants indicated that their crackers became stale within one month of opening the box. All of the consumers indicated that flavor was important for determining eating quality of crackers. Many consumers also agreed that texture (75%), appearance (59.7%), and aroma (45.2%) were important factors when judging cracker freshness. Since the flavor of

most of the peanut flour crackers was rated favorably in the sensory evaluation, one could predict this product to be well accepted by consumers if the crackers can remain fresh for a reasonable period of time, expectedly longer than one month.

CONCLUSION

A new cracker product was successfully created using peanut flour, wheat flour, and rice flour. The final formulation had excellent dough-handling properties. Four flavor varieties were created and compared with

an unflavored peanut flour cracker and with five popular commercial crackers. The quantity of protein and dietary fiber in peanut flour crackers was higher than that of commercial wheat-based crackers, while the carbohydrate content was lower. The peanut flour crackers were also confirmed to be free of trans-fat. This new product can provide consumers with a healthy snack that fits into modern diets which stress an increased intake of protein and reduced intake of carbohydrates. Texture analysis of peanut flour crackers showed that the force required to snap them was considerably lower than that required to snap the commercial crackers, indicating a slightly softer product. The color values of the peanut flour cracker varieties, however, were quite similar to the commercial crackers. The addition of cheddar cheese-flavored powder altered the color of the peanut flour crackers more than the other flavors, but the cheddar cheese variety produced the highest sensory ratings. The peanut flour crackers with Italian seasoning, which received the lowest ratings in the sensory evaluation, were slightly disliked by consumers. The other varieties, including the unflavored control, garlic-flavored, and blackened Cajun-flavored crackers, received intermediate ratings for all attributes and were considered acceptable by the panelists.

In future research, baking trials should include the use of the same type of equipment as currently employed by the commercial cracker-baking industry. Crispness of the peanut flour cracker may improve by baking in a wire mesh band tunnel oven. The shelf life of the product should also be determined to assess the need for preservatives. This product appears to have great potential for the healthy snack food market, particularly the variety with cheddar cheese flavoring added.

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Table VI. Cracker purchasing, consumption, handling, and willingness-to-buy characteristics of taste panel participants

Question	Choices	Percent of Participants (%)
How often to you buy crackers?	< once per week	63.9
	once per week	34.7
	twice per week	0
	three or more times per week	1.4
How often do you eat crackers?	daily	23.6
	weekly	47.2
	monthly	8.3
	occasionally	20.8
What type of crackers do you buy most often?	saltine	58.6
	whole wheat saltine	4.3
	peanut butter	1.4
	whole grain	1.4
	cheese	10
	Wheat Thins	12.9
	graham crackers	1.4
	Ritz	1.4
	Whole Wheat Ritz	2.9
	Cheese-It	2.9
Triscuits	2.9	
Which do you purchase most often?	box	75
	pack (multipack)	18.1
	pack (vending machine)	6.9
Are you concerned about the nutritional quality of your crackers?	yes	77.8
	no	22.2
After opening, how long do you keep your boxed crackers before they go stale?	1 week or less	16.7
	less than 2 weeks	16.7
	less than 1 month	43.1
	more than 1 month	23.6
How do you decide if your crackers are no longer edible? (check all that apply)	appearance (mold, color, etc.)	33.3
	length of storage	30.6
	flavor (stale)	87.5
	texture (too soft, too hard, etc.)	66.7
	other (package date, aroma)	5.6
When you eat crackers, what attributes are important to you? (check all that apply)	appearance	59.7
	aroma	45.2
	flavor	100
	texture (mouth-feel)	75
Would you be willing to pay more for crackers with higher nutritional quality?	yes	80.6
	no	19.4
If you checked "yes" in the previous question, how much more?	5–10 cents more per package	33.3
	11–15 cents more per package	16.7
	16–20 cents more per package	5.6
	21–25 cents more per package	15.3
	more than 25 cents per package	9.7

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