

Whole-Grain Gluten-free Flat Breads¹

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Flat breads are a staple in many cultures worldwide. They are often circular and may be leavened or unleavened (without yeast or chemical leavening agents) and contain single or double layers. A review of flat breads from around the world is provided by Qarooni et al. (5). A wide variety of flat breads are produced globally, including focaccia, *khubz*, *laobing*, lavash, matzo, pita, tortilla, and *yufka*. Pancakes, crepes, and pizza are flat breads that contain baking powder, eggs, and/or yeast.

Wheat is a common ingredient in many flat breads. In Asia and Africa, wheat-based flat breads are commonly baked on a griddle (roti or chapati) or in an oven (naan) or are pan (paratha) or deep-fat fried (puri). A variety of other ingredients, such as meats, vegetables, condiments, and spices, may be incorporated into flat bread doughs. Flat breads can be dried or fried to produce snack chips. They can also be used to make sandwiches, toast, wraps, and roll-ups or can be served with soups, curries, vegetables, and meat dishes. Consumption of flat breads with breakfast, lunch, and dinner meals is common in cultures in which flat breads are staples. As a result of changing demographics and the expanded distribution of ethnic foods among new populations, flat breads are increasing in popularity. Recognizing this trend, some fast food chains have successfully introduced flat bread wraps and sandwiches.

The U.S. Department of Agriculture (USDA) *Dietary Guidelines for Americans 2010* (6) recommends that at least half of all grains eaten should be whole grains and that whole grains should be used in



Courtesy of the Agricultural Research Service.

making food products rather than refined grains. The Whole Grain Council (8) has summarized scientific studies on the health benefits of whole grains: “Studies show that eating whole grains instead of refined grains lowers the risk of many chronic diseases. While benefits are most pronounced for those consuming at least 3 servings daily, some studies show reduced risks from as little as one serving daily.”

The U.S. Food and Drug Administration (FDA) allows a label health claim for foods containing 51% whole grains by weight when the whole grains contain $\geq 11\%$ dietary fiber (7). The FDA defines whole grains as “cereal grains that consist of the intact, ground, cracked or flaked fruit of the grains whose principal components—the starchy endosperm, germ and bran—are present in the same relative proportions as they exist in the intact grain,” which is consistent with the AACC International definition. Potential whole grains include barley, buckwheat, bulgur, corn, millet, rice, rye, oats, sorghum, wheat, and wild rice.

Wheat is the primary grain used in loaf and flat breads due to the special properties of gluten. However, individuals with celiac disease, who are hypersensitive to gluten, must follow a gluten-free diet, which restricts their whole-grain options. The intent of this article is to demonstrate that flat breads are an easy, cost-effective way to increase consumption of whole

grains. Whole grains that do not contain gluten were used to create whole-grain options for gluten-sensitive individuals. Flat breads containing whole-grain corn, brown rice, millet, and sorghum were evaluated.

Preparation

Whole-grain corn, millet, and sorghum flours and brown rice, instant potato flakes, canola oil, and salt were purchased from local markets. Brown rice flour was obtained by pin-milling whole-grain brown rice (160Z, Alpine Company). The composition of the whole-grain flours and potato flakes is listed in Table I. Samples were analyzed for nitrogen, using AOAC method 990.03 (2) and an elemental analyzer (Virio Macro, Elementar Analysen Systeme GmbH); total dietary fiber, using AOAC method 985.29 (2) for crude fat with petroleum ether and an accelerated solvent extractor (ASE 350, Dionex Corp.); ash, using AOAC method 942.05 (1); and moisture, using AOAC method 935.29 (1).

Formulation

The whole-grain flat bread dough formulations used are given in Table II. Each flat bread contained 30–40 g (58–78% by weight) of whole grains and 3 g of dietary fiber. Potato flakes were added to millet, brown rice, and sorghum flours to increase the water-holding capacity of the doughs and to create a desirable texture

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<http://dx.doi.org/10.1094/CFW-57-1-0006>

and mouthfeel in the final product. Corn flour had desirable texture and mouthfeel traits and did not require the addition of potato flakes. In a large bowl, whole-grain flour, potato flakes (for millet, brown rice, and sorghum), salt, and canola oil were mixed. Water was added gradually until the dough began to form a ball. On a lightly floured board, the dough was kneaded until smooth and elastic. The dough was covered and held at room temperature for 30 min. Small portions (about 100 g) of dough were placed on a sheet of wax paper and rolled out with a rolling pin to form thin, flat circles (Fig. 1A). Additional flour or water was added if the dough was too sticky or crumbly. (Flat breads can also be formed into a circle by pressing the dough with moist hands.) The whole-grain flat breads were cooked at 375°F on a griddle that was preheated and lightly oiled. The flat breads were initially cooked for 3 min on each side and turned over with a wide rubber spatula. Each side was then cooked for an additional 1 min to achieve golden brown spots (Fig. 1B). For crispier breads, cooking time can be adjusted as appropriate.

Sensory Evaluation

Cooked flat breads were stored in an insulated lunch box. Each flat bread was cut into eight sections with a pizza cutter and served to panelists. Four sensory panels were held over a three month period; the number of volunteers per panel was 27, 19, 44, and 36. Panelists evaluated the flat breads for color/appearance, odor/aroma, taste/texture, and texture/mouthfeel on a scale of 1–5 (like very much = 5, like slightly = 4, neutral = 3, dislike slightly = 2, and dislike very much = 1). Overall acceptance was scored on a scale of 1–2 (acceptable = 2 and not acceptable = 1).

Results for pooled panel sessions are shown in Table III (pooled $n = 126$; for statistical LSD, $n = 19$). The scores for color/appearance of corn and rice flat breads were similar and positive and were significantly ($P \leq 0.05$) higher than those for sorghum flat bread, which were significantly higher than those for millet flat bread. Lighter colored flat breads (yellow and white) were preferred over those with darker colors. The scores for odor/aroma were significantly different among the flat breads tested (corn > rice >

sorghum > millet). Because each flat bread tested exhibited unique odor/aroma attributes, it might be desirable to develop multigrain flat breads. Scores for taste/texture and overall acceptance for corn, rice, and sorghum flat breads were similar and positive and were significantly higher than those for millet flat bread. This suggests that the strong aftertaste of the millet flat bread was less desirable. Texture/mouthfeel was scored similarly among the flat breads tested.

For whole-grain corn, millet, brown rice, and sorghum flat breads, 81, 31, 87, and 57%, respectively, of panelist responses for color/appearance were positive (4–5, like slightly to like very much) when pooled (Fig. 2A–D). Positive panelist responses for odor/aroma and taste/texture for whole-grain corn, brown rice, and sorghum flat breads ranged from

Table I. Composition of whole-grain flours and potato flakes (% dm basis)^a

Ingredient	Protein	Fat	Minerals	Carbohydrate	Total Dietary		Dry Matter
					Fiber		
Corn	18.06	3.42	1.41	77.11	6.53		91.50
Millet	18.71	6.33	1.57	73.39	6.73		91.28
Brown rice	17.08	7.24	1.10	74.58	3.08		88.94
Sorghum	18.50	3.44	1.45	76.61	6.63		90.67
Potato flakes	18.06	0.42	3.61	77.91	6.97		92.29

^a Nitrogen to protein factors used were 6.25 for corn, sorghum, and potato flakes; 5.83 for millet; and 5.95 for brown rice (4). Carbohydrate = 100 – (protein + fat + ash).

Table II. Formulation of whole-grain flat bread doughs

Whole Grain	Flour (g)	Potato Flakes (g)	Salt (g)	Canola oil (mL)	Water (mL)
Corn	400	...	2	40	520
Millet	300	100	2	40	432
Brown rice	300	100	2	40	420
Sorghum	300	100	2	40	450

Table III. Results of sensory panel evaluation of flat breads^{a,b}

Flat Bread	Color/Appearance	Odor/Aroma	Taste/Flavor	Texture/Mouthfeel	Overall Acceptance
Corn	4.28 ± 0.09 a	4.17 ± 0.08 a	3.73 ± 0.10 a	3.52 ± 0.11 a	1.83 ± 0.03 a
Brown rice	4.28 ± 0.08 a	3.77 ± 0.09 b	3.74 ± 0.10 a	3.67 ± 0.11 a	1.77 ± 0.04 a
Sorghum	3.63 ± 0.09 b	3.41 ± 0.10 c	3.69 ± 0.10 a	3.79 ± 0.10 a	1.79 ± 0.04 a
Millet	2.72 ± 0.11 c	2.90 ± 0.10 d	2.91 ± 0.11 b	3.55 ± 0.10 a	1.50 ± 0.04 b

^a Pooled values are means ± SEM (pooled $n = 126$; for statistical LSD, $n = 19$). Values within columns followed by different letters differ significantly ($P \leq 0.05$).

^b Attributes were evaluated on a scale of 1–5 (like very much = 5, like slightly = 4, neutral = 3, dislike slightly = 2, and dislike very much = 1). Overall acceptance was scored on scale of 1–2 (acceptable = 2 and not acceptable = 1).

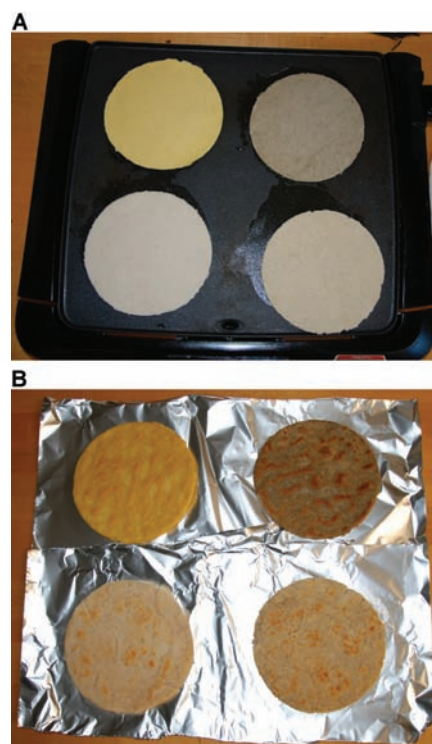


Fig. 1A, Rolled whole-grain gluten-free flat bread doughs (14 cm circles) on a hot (375°F) greased griddle; **B**, cooked flat breads. Top left: corn; top right: millet; bottom left: rice; and bottom right: sorghum (A and B).

54 to 82%, whereas positive responses for millet flat bread ranged from 33 to 37%. Positive responses for texture/mouthfeel for all four flat breads tested ranged from 56 to 71%. Overall acceptance for whole-grain flat breads was 83, 79, 77, and 50% for corn, sorghum, brown rice, and millet, respectively. The lower overall acceptance of millet flat bread might be explained by its darker color and strong aftertaste. Future studies will evaluate varieties of millet with a white or yellowish color and milder flavor, with the expectation of a more favorable overall acceptance.

Benefits of Gluten-free Whole-Grain Flat breads

We have elaborated on many of the reasons for the popularity of the flat breads described by Faridi (3). In addition, gluten-free whole-grain flat breads made with 100% extraction flours, as described here, offer the benefits of whole grains to all consumers, even those with a sensitivity to gluten. The flat breads evaluated in this study are good sources of dietary fiber and minerals and contain the phytonutrients found in the bran portion of the grains. These flat bread formulations are also simple, containing only a few ingredients. Furthermore, flat breads are excellent carriers of other food ingredients, such as meats, vegetables, condiments and spices, either in the dough or in sandwiches and wraps. Flat

bread may be served as a side with curries, soups, vegetables, and meat dishes. Prepared dough may be stored in a refrigerator for several days, and prepared, uncooked flat bread may be separated with wax paper, frozen, and cooked when desired.

The whole-grain gluten-free flat breads described here are simple to prepare and can be made in any home. They also offer advantages for the baking industry and marketers, since only a few ingredients are used. Because flat breads can be processed directly on the conveyor belt, substantial savings could be recognized in equipment. The large surface area of a flat bread also requires less time and space for cooling, and its lower volume reduces shipping and storage requirements. Finally, large numbers of flat bread products can be made with only slight modifications to production lines.

Conclusions

This article demonstrates that nutritious whole-grain gluten-free flat breads are simple to make at home, as well as commercially. The data suggest that whole-grain gluten-free (without yeast or chemical leavening agents) flat breads could be an easy, cost-effective whole-grain option for consumers and producers. These flat breads could become everyday staples for families, including those with members who are gluten sensitive. These

nutritious flat breads are also low in fat and calories and are good sources of fiber and minerals. Sensory panels of in-house volunteers determined that taste/flavor and overall acceptance for whole-grain corn, brown rice, and sorghum flat breads were very high. Data revealed that each type of flat bread tested exhibited significantly different odor/aroma characteristics. For these novel whole-grain corn, sorghum, rice, and millet flat breads, 83, 79, 77, and 50%, respectively, of the panelist responses for overall acceptance were positive. Each flat bread contained 30–40 g (58–78% by weight) of whole grains and 3 g of dietary fiber. Based on panelist responses, creating multigrain gluten-free flat breads would also be desirable. These formulations offer consumers, even those who are gluten sensitive, additional nutritious whole-grain options and could lead to an increase in whole-grain consumption.

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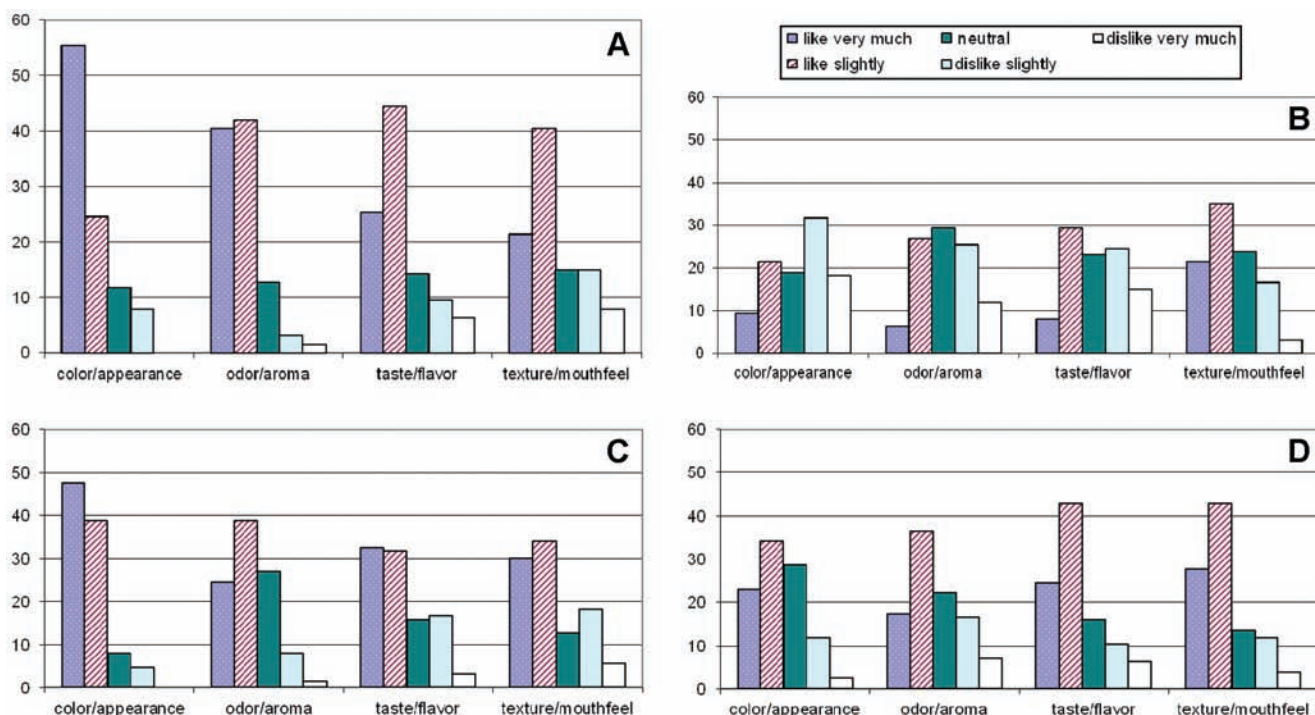


Fig. 2. Pooled panelist responses (%) for whole-grain gluten-free flat breads. A, Corn; B, millet/potato flakes (3:1); C, brown rice/potato flakes (3:1); D, sorghum/potato flakes (3:1) (pooled $n = 126$; for statistical LSD, $n = 19$).

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