

# The Fiber Deficit, Part 3—Beyond Traditional Fiber Sources

## *The Role of Adding Fiber to Food in Improving Fiber Intakes*

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There are several nutrients found to be inadequate in the American diet, but fiber deficit is one of worst. Nearly all Americans fall short in meeting daily fiber recommendations, on average missing target intakes by nearly one-half. This alarmingly low intake has important implications for public health, given the established role of fiber in health promotion and disease risk reduction. The fiber deficit persists despite efforts to promote greater intakes of fruits, vegetables, legumes, and whole grains. However, these approaches also need to address energy balance and the problem of overconsumption of calories. As reported in parts 1 and 2 of this series, whole grains are positioned in dietary guidance as an important source of fiber, and consumers are choosing these foods with the expectation of getting a good source of fiber, yet the amount of fiber in whole-grain products can vary widely. This article will explore the role of fiber added to food as a complementary tactic to help improve intakes of total fiber without adding unnecessary calories. *Nutr Today*. 2013;48(4):168–173

one-quarter are getting the recommended amounts of fruits (29%) and vegetables (25%).<sup>2</sup> This translates to an average intake of only 15 g of fiber per day, far less than the recommended 21 to 38 g of fiber per day for most adults and 19 to 38 g of fiber per day for children aged 1 to 18 years.<sup>3</sup> Given this gap, fiber continues to be highlighted in dietary guidance. Fiber was emphasized in the 2005 DGA as part of the recommendation on “food groups to encourage,” and in the 2010 DGA, dietary fiber was noted as 1 of 4 nutrients with current intakes low enough to be of public health concern for both adults and children.<sup>1</sup> Fiber’s compelling association with reducing the risk of type 2 diabetes and coronary heart disease, as well as its role in promoting healthy laxation and contributing to satiety and weight management, reinforces the fact that widespread inadequate intake of fiber requires immediate attention.

At the same time, there is rising concern about the weight and health status of Americans. The 2010 DGA places greater emphasis on controlling calories to manage weight while making choices to support increased intakes of fiber and other nutrients of concern.<sup>1</sup> This creates a significant challenge for health professionals to help raise current levels of fiber consumption without increasing calories.

As summarized in part 1 of this series, whole grains are positioned in dietary guidance as an important source of fiber, along with fruits and vegetables, yet the amount of fiber in whole grains and products promoting their content can vary widely. This fact, combined with consumers’ fiber expectations from whole grains and the need for regulation of whole-grain label claims, addressed in part 2, suggests that other options should be explored to help bridge the fiber gap. In addition to emphasizing higher fiber choices within the fruit, vegetable, legume, and whole-grain categories, adding fiber to commonly consumed lower-fiber grain foods is a strategy that may prove to be practical and calorie efficient in raising fiber intakes.

This article will take a closer look at the role of different types and sources of fiber added to food as contributing to improved intakes of total fiber. Because current intakes of fiber fall far short of recommendations, other solutions must be explored. Innovations in fiber use and palatability may help consumers improve fiber intakes through a wider variety of fiber-containing food options.

**T**he 2010 Dietary Guidelines for Americans (DGA) recognize that intakes of traditional fiber sources, including fruits, vegetables, and whole grains, continue to fall short of recommended daily amounts.<sup>1</sup> In fact, more than 99% of Americans are not consuming the recommended daily amount of whole grains, and only about

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## THE TOTAL FIBER PACKAGE

Fiber is commonly considered to be obtained by eating foods that contain fibers naturally intact in the plant matrix, which includes cereal brans, nonstarch polysaccharides (eg, cellulose, pectin, gums), plant carbohydrates (eg, inulin, fructans), lignin, and some resistant starch.<sup>3</sup> It is well accepted that these different fibers have unique properties and varying functions in the body. In addition, there is growing recognition of beneficial physiological effects obtained from other nondigestible carbohydrates that may be added to food as an ingredient. This may include intact fiber that is derived from whole grains (eg, wheat bran), fruits, vegetables, legumes, nuts, and seeds; fiber modified from traditional sources (eg, fructooligosaccharides, or FOS, from inulin); or fiber produced from other ingredients such as corn or wheat.

Fiber is not a single chemical compound, but a range of compounds resistant to human digestive enzymes. Despite greater understanding of the properties, functions, and physiologic effects of various types of fiber, there is no single definition for fiber that is in use worldwide. A consistent characteristic across many definitions is the classification of fiber as a carbohydrate that is undigested in the small intestine and that exerts beneficial physiological effects. However, definitions differ in how they address the chemical and physical properties of fiber. Sidebar 1 presents examples of several definitions of fiber in current use.

To address varying types of fiber, the Institute of Medicine (IOM) created a definition based on whether or not the fiber is intrinsic and intact in plant foods.<sup>3</sup> The intrinsic and intact fibers were termed *dietary fiber*, which by definition would include fibers such as wheat bran that is naturally occurring but may also be used in other foods as an ingredient. *Functional fiber*, also referred to as novel, isolated, or added fiber, includes fibers extracted from other sources or synthetically derived and added to foods and that demonstrate a beneficial physiological effect in humans. According to the IOM, regardless of whether fiber is intrinsic in food or added, both types of fiber are components of the total fiber package, referred to as *total fiber*.<sup>3</sup> The Adequate Intake level established by IOM is based on total daily fiber intake and does not differentiate between dietary or intrinsic fiber and functional fiber.

## UNDERSTANDING THE ROLE OF FIBER ADDED TO FOODS

There is significant scientific evidence that fiber added to food confers similar benefits as intrinsic fiber. In fact, most clinical intervention studies of fiber's physiological benefits have been conducted with isolated fibers rather than whole, fiber-containing foods.<sup>3,4</sup> Nondigestible fibers, whether intrinsic or added to foods, share a common

### Sidebar 1: Current Definitions of Fiber

American Association of Cereal Chemists<sup>10</sup>: Dietary fiber is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Dietary fibers promote beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation.

Institute of Medicine<sup>3</sup>: Dietary fiber consists of nondigestible carbohydrates and lignin that are intrinsic and intact in plants. Functional fiber consists of isolated, nondigestible carbohydrates that have beneficial physiological effects in humans. Total fiber is the sum of dietary fiber and functional fiber.

Codex Alimentarius Commission<sup>11</sup>: Dietary fiber means carbohydrate polymers<sup>a</sup> with 10 or more monomeric units,<sup>b</sup> which are not hydrolyzed by the endogenous enzymes in the small intestine of humans and belong to the following categories:

- Edible carbohydrate polymers naturally occurring in the food as consumed;
- Carbohydrate polymers that have been obtained from food raw material by physical, enzymatic, or chemical means and that have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities; and
- Synthetic carbohydrate polymers that have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities.

<sup>a</sup>When derived from a plant origin, dietary fiber may include fractions of lignin and/or other compounds associated with polysaccharides in the plant cell walls. These compounds also may be measured by certain analytical method(s) for dietary fiber. However, such compounds are not included in the definition of dietary fiber if extracted and reintroduced into a food.

<sup>b</sup>Decision on whether to include carbohydrates of 3 to 9 monomeric units should be left up to national authorities.

feature within the intestinal tract; that is, they pass undigested to the large intestine, where they are available for fermentation by the bacteria.

In 2010, the International Life Sciences Institute sponsored a session at the Ninth Vahouny Fiber Symposium with the objective to build consensus among the scientific community on what constitutes a physiological health benefit of fiber.<sup>5</sup> Sidebar 2 highlights a core list of beneficial physiologic effects agreed upon by participants at this symposium and other proposed benefits that received support but may require further study. The specific beneficial outcomes of different fiber types were acknowledged as contributing to the overall benefits associated with total fiber intake. This growing recognition of the positive health benefits of varying types of fibers has contributed to their greater use in the food supply.<sup>4</sup> Table 1 outlines the demonstrated effects and primary sources of various fibers currently being

Sidebar 2: Beneficial Physiological Effects Associated With Consumption of Dietary Fiber<sup>5</sup>

• Reduction in blood total and/or low-density lipoprotein cholesterol
• Reduction in postprandial blood glucose and/or insulin levels
• Increased stool bulk and/or decreased transit time
• Fermentability by colonic microflora
Additional benefits to consider with further study:
• Weight loss/reduction in adiposity
• Increased satiety
• Positive modulation of colonic microflora
• Reduced blood pressure

used in foods. Many types of fiber can be added to foods with minimal perceptible effects on taste.

Certain fibers not only deliver physiological benefits but also possess other functional and nutritional characteristics. For example, inulin and oligofructose not only serve as prebiotics that stimulate the growth and/or activity of friendly bacteria but can also be used to replace fat and sugar in food products, thereby helping to lower total energy of a food while increasing its fiber content.<sup>6</sup> In addition, these fibers may help to improve mineral absorption from the digestive tract, such as calcium, which is particularly important among adolescents and postmenopausal women.<sup>6</sup>

The IOM acknowledges that getting fiber from a variety of sources to increase total fiber intake offers differing health benefits specific to each source. Adding specific types of fiber to food products is not a new concept. Oat fibers, beta-glucan, psyllium, and other types of fiber have been used in breads, ready-to-eat cereals, and cereal bars for years. In fact, the Food and Drug Administration allows an on-pack health claim that highlights the role of foods containing beta-glucan and psyllium, whether naturally occurring or added, in reducing the risk for cardiovascular disease.<sup>7</sup> This illustrates the targeted use of adding fiber to foods to obtain a specific physiologic benefit. However, dietary guidance on fiber often neglects added fiber and focuses primarily on increasing intake of plant-based foods with intrinsic fiber, including fruits, vegetables, legumes, and whole grains. As a result, the role of foods with fiber added in health promotion is poorly understood by both health professionals and consumers.

### Health Professional Perceptions of Adding Fiber to Food

To explore the understanding and perceptions of added fiber, an online survey of 150 registered dietitians (RDs),

screened from both general practice and medical specialty practice groups, was conducted in August 2010 by the Kellogg Company. The participants were in practice for an average of 10 years and worked in a broad range of practice settings, including hospitals, foodservice, government, community, research/academia, private practice, food retail, and schools.

In general, fiber was broadly perceived by RDs as an underconsumed nutrient of concern with a resulting negative impact on human health. A significant proportion of RDs reported spending “some” or “a lot” of time communicating about the importance of increasing fiber intake. Other key observations included the following:

- Obtaining fiber from natural, whole food sources was the preferred option for addressing the fiber deficit. However, RD respondents were generally supportive of fiber added to foods.
- About two-thirds of survey respondents perceived foods with fiber added as playing a positive role in addressing the fiber deficit. The remaining RDs noted lack of confidence in the benefits of fiber added to foods. These perceptions were driven by concern about processed foods’ healthfulness and the belief that added fibers are not equivalent to natural sources of fiber in offering the same benefits.
- The level of acceptability of fiber added to specific foods was strongest for traditional sources of fiber, including bread, cereal bars, and ready-to-eat cereals.

Overall, interest in and support for foods with fiber added was largely driven by the need for palatable fiber-added foods and less by the benefits delivered by fiber, confirming that taste is a key factor for RDs in recommending foods with fiber added. The findings also suggest the need for additional research and education regarding the benefits, including caloric efficiency, delivered by added fibers within a range of food sources. In addition, it was evident that education on the characteristics, uses, and health benefits of added fibers will be fundamental to broad-based acceptance with guidance on how to educate consumers about the use of foods with fiber added.

### PRACTICAL IMPLICATIONS OF ADDING FIBER TO FOODS

Current recommendations to increase fiber intake pose a challenge to consumers who must manage calorie intake while maximizing nutrients, including fiber. As discussed in part 1, a modeling study that simulated various approaches to increase fiber in Americans’ diets found that increasing consumption of only whole-grain foods to the recommended levels has the potential to help adults increase fiber intake, but the caloric cost may be significant.<sup>8</sup> Using intake data obtained from National Health and Nutrition Examination Survey 2003–2006, this modeling study also measured the effects on total calories when

**TABLE 1** Types and Effects of Fiber Ingredients<sup>3</sup>

Examples of Types of Fiber Added to Foods	Potential Physiological Effects	Primary Source
Beta-glucan ( $\beta$ -glucan) and oat bran	Blood lipid lowering	Oats and barley
	Attenuates blood glucose response	
Cellulose	Laxation	Plant foods
Chitin/chitosan	Blood lipid lowering (as seen in animal studies)	Fungi or shellfish
Guar gum	Blood lipid lowering	Guar bean (legume)
	Attenuates blood glucose response	
Inulin/oligofructose/fructooligosaccharide	Laxation	Chicory root
	Blood lipid lowering	Jerusalem artichoke
		Synthesized from sucrose
Pectin	Blood lipid lowering	Plant foods
	Attenuates blood glucose response	
Polydextrose	Laxation	Synthesized from dextrose (glucose)
Psyllium	Laxation	Psyllium husk (plant)
	Blood lipid lowering	
Resistant dextrins	Blood lipid lowering	Corn and wheat
	Attenuates blood glucose response	
Resistant starch	Laxation	Plant foods
	Attenuates blood glucose response	
Soluble corn fiber <sup>a</sup>	Attenuates blood glucose response	Corn
Wheat bran	Laxation	Wheat

<sup>a</sup>Kendall et al. *J Am Coll Nutr.* 2008;27:711–718.

intake of all fiber-containing foods increased, including fruits, vegetables, and grains, and the effects of adding fiber to grain foods that are low in fiber.

When amounts of fiber-containing foods were increased incrementally from 10% to 100%, fiber intake ranged from 16.9 to 28.5 g/d, whereas energy intake increased by up to 1042 calories per day.<sup>8</sup> Alternatively, adding 2.5 or 5.0 g of fiber per serving to grain foods low in fiber resulted in average fiber intakes of 24.7 and 39.1 g/d, respectively, with a modest or no increase in energy intake.<sup>8</sup> This was based on the assumption that fiber tends to displace other digestible nutrients, such as fat, when fiber-added versions of foods are formulated. For some foods, however, this assumption may not hold true. Simply increasing intakes of all fiber-containing foods may indeed help close the fiber gap, but it will be at the cost of additional calories. Therefore, adding fiber ingredients to increase the

fiber content of select foods, while emphasizing consumption of higher-fiber fruits, vegetables, and grain products, may be a practical solution to help bridge the fiber gap, without significantly increasing calories.

As presented in part 2, consumers associate grains with fiber, and they are choosing products containing whole-grain label statements with the expectation of getting sufficient fiber in their diets. However, products with whole-grain claims supply varying amounts of fiber; in fact, many supply less than that defined as a good source of fiber. Adding fiber to foods that consumers expect to contain fiber, such as breads, cereals, cereal bars, and crackers, is a logical approach to increasing fiber intake. Research on consumer acceptance and use of nontraditional foods with added fiber, such as yogurt, cheese, and beverages, is needed to determine if these foods are suitable and effective vehicles for delivering fiber.

**TABLE 2 Typical Menu Illustrating Small Step Fiber Substitutions**

Typical Menu for an Adult Woman <sup>a</sup>	Fiber, <sup>b</sup> g	Examples of Fiber Substitutions <sup>c</sup>	Fiber, <sup>b</sup> g
Breakfast			
1 cup frosted flake cereal	1.3	→ 1 serving (24 biscuits) frosted shredded wheat	6
1 cup low-fat milk			
1 small banana	2.6	1 small banana	2.6
1 cup coffee with 2 tsp sugar, 1 tbsp half & half			
Lunch			
Ham and Swiss sandwich			
2 oz ham luncheon meat			
1 oz Swiss cheese			
2 tsp light mayo			
1 leaf lettuce			
1 sandwich roll	1.2	→ 1 whole-wheat sandwich roll <sup>d</sup>	3
1 oz potato chips	1.2	→ ½ cup baby carrots	3.5
8 fl oz sweet tea			
Dinner			
Spaghetti with meatballs			
1 cup pasta	2.5	→ 1 cup whole-grain pasta <sup>d</sup>	6
2 oz meatballs			
½ cup marinara sauce	2	½ cup marinara sauce	2
1 tbsp parmesan cheese			
Tossed salad			
2 cups iceberg lettuce	1.4	→ 2 cups romaine lettuce	2
2 tbsp light Italian dressing			
Water			
Snack			
3 chocolate chip cookies	0.6	→ 1 fiber-added chocolate chip bar	9
Total fiber	13		34
Calories	1590		1480

<sup>a</sup>Menu represents typical foods and eating pattern of women consuming low-fiber cereal/bars based on NPD's Nutrient Intake and National Eating Trends database and data from MyPyramid Servings Intakes 2004 (What We Eat in America, NHANES 1999-2002). Illustrated menu changes maintain or decrease total amounts of calories, fat, added sugars, and sodium.

<sup>b</sup>Fiber amounts in food items less than 0.5 are not indicated but are reflected in the total fiber calculation.

<sup>c</sup>Although the typical consumer may not make all of these changes, recommended total fiber of at least 25 g/d for women can be achieved by making just 2 to 3 small changes. For example, choosing a higher fiber cereal and substituting a fiber-added product, such as a cereal bar, will increase fiber in this menu to 26 g while maintaining energy intake at less than 1600 calories.

<sup>d</sup>Assumes a product with a minimum of 3 g of fiber per serving ("good source" of fiber).



## Small-Step Substitutions

The approach of encouraging “small-step” changes in food choices has been proposed to help consumers move toward meeting recommended dietary patterns. This strategy can also be applied to increasing fiber intakes. To illustrate how small changes to typical eating patterns of men, women, and children can have a substantial impact on daily fiber intakes, sample menus were developed to represent the usual daily diet of specific target groups, modeling average fiber intakes at various energy levels. The menus highlighted foods actually consumed by Americans, as obtained from the NPD Group’s Nutrient Intake Database and National Eating Trends database, to illustrate the most relevant small step opportunities for increasing fiber.<sup>9</sup> Small-step examples included switching typical food choices with similar options that provide at least a good source of fiber, including products with fiber added. For example, Table 2 illustrates a typical menu for a woman eating approximately 1600 calories with 13 g of fiber. Several examples of menu changes are indicated to help raise the fiber content of this menu. As few as 2 small changes in this menu, such as choosing a higher-fiber cereal at breakfast and replacing cookies with a cereal bar with added fiber, can result in a net increase of 13 g of fiber while maintaining calorie intake. Menus that mirror typical eating habits but highlight changes in food choices that provide at least a good source of fiber can be used as educational tools to illustrate how to complement natural sources of fiber with added fiber options to help meet daily recommendations without increasing calories.

## THE FUTURE OF FIBER

To help Americans reap the benefits of adequate fiber in health promotion and disease risk reduction, a 2-pronged approach is needed. First, dietary guidance should continue to encourage Americans to enjoy more fruits, vegetables, and whole grains to ensure that daily intake recommendations are met while emphasizing choices within and among these food groups that provide at least a good source of fiber. Simply meeting daily food group recommendations does not guarantee adequate fiber intake because the amounts of fiber vary widely within these food categories. For example, the 2010 DGA recognizes that whole grains vary in their fiber content and advises using the Nutrition Facts label to compare whole-grain products to find choices that are a good (10%–19% daily value) or excellent ( $\geq 20\%$  daily value) source of fiber.<sup>1</sup>

A second strategy is adding fiber to lower-fiber grain foods that are commonly consumed, including foods containing

whole grains, of which consumers already expect to be delivering at least a good source of fiber. Adding fiber to select foods can play an important role in helping to increase total fiber intake, with minimal impact on calorie intake. The 2010 DGA acknowledges fiber added to foods as contributing to the total fiber content of foods.<sup>1</sup>

Advances in fiber knowledge, ingredients, and innovations have resulted in a greater variety of health-promoting fibers available for use in foods. These different types of fiber may offer diverse health benefits, yet all fibers that demonstrate a physiological benefit can contribute to overall health and to total fiber intakes. Fiber added to select foods can be part of the solution, especially when added to commonly consumed foods, offering a calorie-neutral strategy to help Americans reach recommended fiber intake goals.

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