

Dietary Fiber Future Directions: Integrating New Definitions and Findings to Inform Nutrition Research and Communication^{1,2}

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ABSTRACT

The CODEX Alimentarius definition of dietary fiber includes all nondigestible carbohydrate polymers with a degree of polymerization of 3 or more as dietary fiber with the proviso that they show health benefits. The global definition, if accepted by all authoritative bodies, offers a chance for international harmonization in research, food composition tables, and food labeling. Its nonacceptance highlights problems that may develop when definitions vary by region. The definition requires that the research community agrees upon physiological effects for which there is substantial scientific agreement, e.g., fibers' effects on laxation and gut health, on attenuating blood lipids and blood glucose and insulin, and in promoting fermentation in the large bowel. The definition also necessitates the delineation of research protocols to prove the benefits of various isolated and synthesized fibers. These should emanate from evidence-based reviews that fairly weigh epidemiological data while considering that added fibers are not reflected in many food composition databases. They then should include well-controlled, randomized, control trials and utilize animal studies to determine mechanisms. Agreement on many study variables such as the type of subject and the type of baseline diet that best fits the question under investigation will also be needed. Finally, the definition establishes that all types of fiber can address the severe fiber consumption gap that exists throughout the world by recognizing that the combination of fiber-rich and -fortified foods increases fiber intake while allowing consumers to stay within allowed energy levels. *Adv. Nutr.* 4: 8–15, 2013.

Introduction

The realization nearly 50 y ago that dietary fiber is important to good health has resulted in a “holy grail” quest to have a definition that includes all the types of substances that fulfill the criteria set by the definition. Currently, existing definitions may fail to capture all the nondigestible material in food. Thus, the issuance by CODEX Alimentarius of an international definition of dietary fiber in 2009 marked an

important step forward for fiber research and nutrition (see Appendix). A single worldwide definition enables research studies to be comparable, because all would include the same materials measured in the same way. The fact that the CODEX process took over 16 y is testament to the difficulty in reaching international consensus on the definition.

The CODEX definition has been adopted or reaffirmed by many national authorities, but it did not completely solve the issue of international harmonization, because a footnote to the definition allows national authorities to choose whether or not to include nondigestible polymers that are shorter than 10 sugar units [degree of polymerization (DP) ≤ 10]. Thus, the DP issue could impair international harmonization if some countries decide not to accept these short chain oligomers as dietary fiber.

This paper will review the CODEX definition and its acceptance in countries around the world. It will feature the 3 CODEX classifications of fiber. These include fibers in category 1 that are intrinsic and intact; in category 2 that are extracted from food materials by some physical, chemical, or mechanical means; and in category 3 that are synthesized

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or modified. Fibers in categories 2 and 3 require proof of their physiological benefits and data supporting this must show substantial scientific agreement.

Research protocols are needed that will enable the approval of fibers from categories 2 and 3. Such protocols will likely require thorough characterization of the fiber in question and evidence-based reviews (EBRs) of existing data collating and synthesizing the existing literature regarding a particular isolated or synthesized fiber. Such reviews can help identify data gaps to set the direction for future fiber research. Further, research will be needed that not only clarifies the importance of adequate total dietary fiber intakes but also delineates the benefits and synergies that result from the intake of fibers of a variety of types and from a variety of sources. This review will try to outline some of the issues associated with each of these goals.

Current status of knowledge

Dietary fiber became an important nutritional concept in that late 1960s and early 1970s with the launching of the dietary fiber hypothesis by a team of British physicians, Burkitt, Painter, Walker, and Trowell (1–3). They noted that diseases regularly seen in Western countries were rare in rural Africa. It was their contention that the difference in disease rates was due to differences in diet, specifically the marked difference in intake of unrefined carbohydrate. Thus, the dietary fiber hypothesis emerged. It suggested that the occurrence of conditions from constipation to coronary disease (Table 1) could be reduced with the addition of dietary fiber to the diet (1–3).

With dietary fiber as part of the nutrition canon, advances in research and understanding of the kinds of materials and the many physiological benefits suggested a need to refine the definition of dietary fiber and to improve the methods required to measure it. The progression of existing dietary fiber definitions shows nuanced refinements in the definition. These definitions are found in the following references (4–14). The difficulty in arriving at a definition is due to many factors, but 3 important ones are: 1) the inability to define dietary fiber as a single chemical entity or group of chemically related compounds; 2) the many and varied physiological functions it performs; and 3) analytical difficulties in accurately characterizing it (13).

Table 1. Diseases and conditions suggested by the fiber hypothesis of 1970¹

Constipation
Diverticular disease
Hiatal hernia
Appendicitis
Varicose veins
Piles (hemorrhoids)
Gallstones
Obesity
Cancer of the large bowel
Coronary heart disease
Diabetes

¹ Adapted from (1) with permission.

In many ways, the discovery period for dietary fiber mirrors the discovery of vitamins and their functions. Both fibers and vitamins are heterogeneous groups of compounds. Both have unique and overlapping functions and their roles in improving nutrition and importance to health are without dispute. As with vitamins, health is optimal when all the various fiber entities are ingested in the recommended amounts so that they can complement and augment each other.

Dietary fiber, as defined by all existing definitions, is recognized to be a group of carbohydrate polymers and oligomers that escape digestion in the small intestine and pass into the large bowel, where they are partially or completely fermented by the colonic microflora. Many definitions recognize that dietary fibers can be intrinsic in foods, extracted from edible material, synthesized, or modified and added back to the food or the diet. The 2009 CODEX (4) dietary fiber definition and the recently approved definition by Health Canada (5) both recognize this. The Institute of Medicine definition proposed in 2002 bears similarity with and differences from the CODEX definition (9). It is similar to the definition in that it recognizes carbohydrates that are not digested in the small intestine. It is different in that the CODEX definition enfranchises all materials, intrinsic or added, that have been proven to function physiologically as dietary fibers. The Institute of Medicine definition gives them different names: dietary fiber, functional fiber, and total fiber. This creates a scenario that reserves the term dietary fiber to be used only for those fibers that are intrinsic and intact. For some, this nuanced difference in naming appears to make functional fiber unqualified to be called dietary fiber and in fact suggests that it is fake fiber. This is an ironic conclusion, because there are much more intervention data on the benefits of isolated fibers than there are on fibers found in foods. Epidemiological data dominate the evidence proving the benefits of fibers inherent in foods. The difficulty with these data is attributing the beneficial effect to the fiber and not to other aspects of fiber-containing foods such as fruits and vegetables or whole grains.

Dietary fiber, like other nutrients, only warrants interest from nutritionists and health professionals because of its physiological benefits. Nearly all dietary fiber definitions that include materials extracted from foods or those that are synthesized or modified and then added back to food require proof of at least one health benefit in order to attain the status of dietary fibers. While the metabolic fate of a dietary fiber does not differ by its origin as inherent in the food or added to the diet, there are some who argue that fibers that are intrinsic or intact, as measured by nonstarch polysaccharides, behave differently, because fiber in its original matrix has other nutrients attached or is processed differently (15). Yet nearly all recent definitions recognize both fiber types.

The recommendation for the use of all types of fiber is underscored by poor fiber intakes worldwide. A huge fiber gap is documented for every age and gender subgroup in the U.S. NHANES (2003–2006 intake data) (16). In most

categories, <5% meet the Adequate Intake level for dietary fiber intake (16) (Table 2). The average intakes in the US are 12–15 g/d dietary fiber. Thus, intakes are one-half to one-third of the Dietary Reference Intake for dietary fiber (17). As a result, the 2010 Dietary Guidelines Advisory Committee report continues to list dietary fiber as a nutrient of concern (18). To address the extreme intake deficit, fibers from all categories are useful.

Discussion of the Codex Definition 2009

The CODEX dietary fiber definition was agreed to and released after over 16 y of deliberations. It reads as follows (4): Dietary fiber means carbohydrate polymers with 10 or more monomeric units that are not hydrolyzed by the endogenous enzymes in the small intestine of humans and belong to the following categories: 1) edible carbohydrate polymers naturally occurring in the food as consumed; 2) carbohydrate polymers, which have been obtained from food raw material by physical, enzymatic, or chemical means and which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities; and 3) synthetic carbohydrate polymers, which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities.

Footnote 1 states, “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 if they are added as isolated components.”

Footnote 2 states that the “decision on whether to include carbohydrates of 3 to 9 monomeric units should be left up to national authorities.”

Footnote 1 recognizes that “associated substances” and lignin when present in the food may be part of the dietary fiber complex and may be measured as such. Footnote 2

Table 2. A sampling of NHANES gender/age categories and the percent that meet the dietary fiber requirement¹

NHANES gender category	Age range, y	Percent of NHANES 2003–2006 with fiber intakes ≥ adequate intake
Children, both genders	4–8	3
Male	9–13	1
	14–18	0
	19–30	0
	31–50	0
	51–70	4
	71+	5
Female	9–13	1
	14–18	1
	19–30	3
	31–50	3
	51–70	13
	71+	15

¹ Adapted from (16) with permission. *n* = 12,761 total (NHANES 2003–2006).

allows for national authorities to decide whether to include oligomers with DPs between 3 and 9. The next section will discuss this issue. The other issue that was left undefined in the final version of the CODEX definition was agreed upon physiological effects. These will be discussed in subsequent sections.

The DP 3–9 issue

Allowing national authorities to decide on the inclusion of DPs 3–9 results in the possibility of 2 operative definitions of dietary fiber. Thus, food labeling, food composition tables, the conduct of dietary fiber research, and the interpretation of the findings might differ by country. If research in one region includes oligomers with DPs 3–9 and in another excludes them, there is the possibility of different outcomes or inconsistent results.

Even with a single substance such as inulin, which has a variety of chain lengths, the building of a scientific basis to support its health benefits becomes challenging when different studies employ different definitions. Food composition tables and food labels would have different fiber values in regions that accept DPs 3–9 compared with those that do not (19).

The exclusion of DPs 3–9 is a historical artifact stemming from early fiber methods, which started with an alcohol precipitation step. This washed many short-chained materials (DP ~9 or less) into the effluent. Contrary to beliefs held by some, the separation is not precise, because it allows loss of some fibrous compounds with DP >9 (10,11,13,14). Thus, the exclusion of fibers with a DP of 3–9 does not make sense analytically (11,13,14).

Nor does the exclusion of oligomers with a DP of 3–9 seem logical from a physiological point of view, because these substances fit the dietary fiber definition in all aspects. First, these are neither digested nor absorbed by the enzymes in the small intestine. Second, these are fermentable in the large intestine (20,21). Third, they have documented effects such as increasing mineral absorption, altering beneficial colonic bacteria, and modulating laxation (20–23).

Fermentability of oligosaccharides

Carbohydrates with 3–20 sugar units are called oligosaccharides. If the bonds joining the sugars are not split in the human small intestine, they are dietary fiber. In the large intestine, all oligosaccharides are readily fermentable and can act as prebiotics. The amount, type, and rate of SCFA production change with the state of gut intestinal flora and its mix of species, chain length of the oligomer, and the fiber matrix. Some pure forms of oligosaccharides may cause greater gas production and a greater pH drop than that seen with some whole foods containing fiber or foods with added fiber (23,24). However, neither the chain length nor the DP specifically predicted SCFA production in vitro. Some studies showed that mixtures of chain lengths may affect SCFA production (23,24). For example, with a mixture of 90% DP >10 and 10% DP <10, there were significantly more total SCFAs and acetate than in other samples tested.

Oligomers with DP >20 produced the least butyrate. Fructooligosaccharides are polymers of fructose (fructans) joined by linkages that are not split in the enzymes in human small intestine. These short-chain fructans (≤ 20 units) ferment faster than larger fructan molecules such as some inulins that range in size from <20 to 2000 sugar units, according to a study comparing DP 2–20 and inulin DP 3–60. This faster fermentation of fructooligosaccharides means that there is greater inulin fermentation further down in the colon. Mixtures of oligomers with varying chain lengths gave different results from isolated compounds of uniform chain lengths. This is important information, because those found in foods and those added to the diet both show physiological effects and can work together to create a synergy (23–26). These data support the view of experts attending the Vahouny Conference in Washington DC in 2010. The participants strongly agreed that there is no scientific basis for a cutoff point at DP <10 (27). Finally, if these materials are not allowed status as dietary fiber, they would be cast into a “no-man’s land” of being neither a digestible carbohydrate nor a dietary fiber (28).

Dietary fiber definition/methods: the importance of harmonization

A science-based, harmonized definition and method ensure: 1) accurate measures of fiber in foods for assessment of scientific intake and conducting research; 2) viable comparison of intakes across geographic regions and findings of research studies; and 3) similarity in food labeling to lessen trade barriers.

Different definitions cause difficulty in interpreting the intake data from several countries. Data from China using the AOAC method shows that males ingest 15.7–17.6 g/d and females consume 13.5–16.4 g/d, and in Belgium, males ingest 23 g/d and females consume 17.3 g/d (29,30). Intake data from the UK derived using the nonstarch polysaccharide method showed that males ingest 13.5–15.5 g/d and females consume 11–14.3 g/d (31). (The intake data seems quite different, but using nonstarch polysaccharides gives lower values. Because there is no direct conversion factor, comparing the intakes with any kind of accuracy may not be possible.) For calculating intake, nearly all intake studies rely on food composition tables, which may have values for many foods that do not capture some of the newly enfranchised fibers. At the Dietary Fiber 2012 international conference in Rome, there was discussion about the need to update the tables coupled with concern about the lack of resources (particularly in countries where resources are scarce) needed to update the food composition tables to include all the fibers enfranchised by the CODEX definition. At present, there is no conversion factor that can be used to correct the current table values. In addition, food label values may vary depending on whether fiber is calculated from food composition tables or analytically determined. If the latter, then the label value depends on methods used capture the various fibers in the CODEX definition.

Proving physiological effects of fibers in categories 2 and 3

Materials fitting into categories 2 or 3 of the CODEX dietary fiber definition must have at least one physiological effect that is of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities.

Thus, the Codex definition necessitates generation of the following types of information. There is need for EBRs on various fiber types. These studies should specifically define attributes of the material such as the form and type, particle size, and molecular weight, as shown to be important for fibers such as β -glucan (32) (Table 3). Further, the EBR would note diet characteristics accompanying the fiber, baseline diet, mode of feeding (e.g., whether fed alone or with meals, as a single bolus in a liquid or added to foods), the total dose, characteristics the subjects, and other important study conditions that might affect the results.

Although there are no epidemiological studies that specifically look at added fiber intake, intervention studies on health benefits of feeding added fibers dramatically outnumber those that feed fibers that are naturally present in food. One reason for the lack of epidemiological studies with isolated fibers is that these materials are often omitted from food composition databases and if they are included, their contribution is not separable from total dietary fiber in the intake data.

To assess the effects of isolated fibers and fibers in food, there needs to be a protocol to fairly weigh all types of data for all types of fiber. Once this is decided, a careful assessment of the findings of the EBR can show the research gaps to be addressed. With the gaps addressed, a dossier that could be used to petition approval of an added fiber could be constructed. Researchers will need to agree on methods and biomarkers and the amount necessary to constitute a meaningful physiological change. Ideally, this should be agreed upon so they fit all countries and jurisdictions.

The baseline diet, for such studies, also needs to be decided. However, this is not easy, because it is not clear whether the diet should contain very little fiber, be the “usual” diet with a baseline of 12–18 g/d of dietary fiber (depending on the country), be constructed with a certain baseline of fruits and vegetables and grains, or have adequate quantities of micro- and macronutrients. Should the baseline diet change depending on the endpoint being measured? For

Table 3. Effect of molecular weight and amount of β -glucan fiber in an extruded cereal on percent LDL-cholesterol reduction¹

Oat β -glucan ²	Subjects/ group	Molecular weight	LDL change from control	Significance
<i>g/d fed</i>		<i>g/mol</i>	<i>%</i>	
3	86	2,210,000	–5.5	*
4	67	850,000	–6.5	*
3	64	530,000	–4.7	*
4	63	210,000	–2.3	NS
Wheat fiber cereal control	87			

¹ Adapted from (32) with permission. *Different from wheat control. NS, not significant.

² Divided doses, twice daily for 4 wk.

example, if the question is about fiber's ability to modulate blood glucose or cholesterol, should the baseline diet be constructed to be high in the offending dietary components? Another question is in regard to fiber; should only the test fiber be fed, or should there be a baseline mixture of fibers and a dose of test fiber added?

Data from Pal et al. (33) show that supplemental fiber added to a baseline diet that had more fiber than many Western diets improved measures of body weight and cardiovascular biomarkers. These data (Table 4) indicate a synergy between fibers in food and added fibers. Should such synergies be considered? Further, when fibers are compared, should fiber levels be equalized by weight or effectiveness or some other criteria? Should the subjects be regarded as normal, or can they be overweight but have no other signs of disease? Should they be at risk for disease or endpoint being studied or have the disorder in question? Are studies needed with both normal and at-risk subjects? May data from "super compliers" be considered and the rest discarded? For example, an intervention study showed that fiber added to the diet did not affect the recurrence of polyps (34). However, an analysis with those who were dubbed super compliers showed a 35% decrease in polyp recurrence (35). This begs the question about the use of all data from the study or only the data from those who have followed the protocol.

Potential physiological properties included in drafts of the CODEX definition

In the 2006 draft definition, the following physiological effects were included in the fiber definition: 1) a decrease in intestinal transit time and increase in stool bulk; 2) an increase in fermentation by colonic microflora; 3) a reduction in blood total and/or LDL cholesterol concentrations; 4) a reduction in postprandial blood glucose and/or insulin concentrations. It should be noted that the final, approved definition did not include a list of physiological effects (4).

The listed physiological effects were also those agreed upon by fiber experts who completed the Vahouny Survey (27). The following section will briefly address questions that must be agreed upon to determine if a fiber product affects laxation. First, what measure(s) are needed to determine changes in laxation? Can the measures be subjective with improvements such as "the stool was a better

consistency or easier to pass"? What is the degree of change needed to say there is an effect? Should the control diet be the normal constipating U.S. diet? Should the subjects have normal bowel habits and what is the definition of normal? Can the subjects have gut issues such as irritable bowel syndrome? If increased laxation is the outcome, what should be the baseline? Does each person serve as his or her own control, or is there an average fecal output per body size (36)? The data in Table 5 are means for stool output for the various fiber types (37,38).

Fiber and serum cholesterol. For fiber claims attached to cholesterol lowering, the oat bran health claim may serve as a useful precedent (39). However, does this body of literature and the methods used 20 y ago provide an acceptable protocol? Issues surrounding the baseline diet are also relevant. Should the diet be an AHA Step One diet as the baseline? Questions about the appropriate subjects and how many and the number of studies must be resolved. Should the standards applied for drugs apply to food supplements? Analogous questions are needed for fiber and its effects on blood glucose and insulin. Should subjects have impaired glucose tolerance or insulin resistance? How much improvement in blood glucose is needed for a claim, or is glucose and insulin normalization required?

Physiological effects on which there is some agreement

Fiber positively modulates colonic microflora (40). The question of baseline and normality is particularly difficult in this emerging area. The microbiome appears to have fingerprints. It seems to change over time as people emigrate to a new environment and use antibiotics and other drugs and may affect weight loss, adiposity, and disease risk (41). It is not clear what the starting point should be or what changes in numbers and types of species mean to health outcomes. Do increases in beneficial bacteria such as bifido bacteria or lactobacillus or decreases in pathogens such as clostridia mean improved health? Changes in gut bacteria have recently been associated with diabetes and weight (42). Fermentation in the gut means the production of SCFA and a drop in pH (41). Most agree that SCFA and pH reduction may be beneficial, but the amount and proportion needed are not yet determined. Questions remain about whether

Table 4. Effect of food fiber and added fiber on body and blood lipid characteristics compared with a control diet¹

Diet	Fiber g/d	Statistically lower than the control					
		Weight	BMI	Percent body fat	TG	Insulin	LDL cholesterol
Control	20						
Healthy pattern fiber-rich foods	31	↓	↓		↓	↓	↓
Dietary fiber supplement	55	↓	↓	↓			↓
Healthy pattern + dietary fiber supplement	59	↓	↓	↓	↓	↓	↓

¹ Adapted from (33) with permission. 12 wk in overweight and diabetic subjects, n ≥ 15/group.

Table 5. Average g stool/amount of fiber fed¹

Fiber source	Laxation
	<i>g feces/g fiber</i>
Wheat bran	5.4
Psyllium	4.0
Oats	3.4
Corn	3.3
Legumes	2.2
Pectin	2.1
Resistant starch ²	1.1
Inulin	1.0

¹ Adapted from (37,38) with permission.

² Personal communication with Rhonda Witwer, Ingredient, formerly National Starch, Bridgewater, NJ

there can be too much of any type of SCFA and about other fermentation and the amount of gas produced.

Also, the tolerance for various fibers differs. So while there is no Upper Level set for dietary fiber and some vegetarians consume well over 80 g/d of fiber, the tolerance for certain added fibers would indicate that intakes of pure sources of these should not exceed specified levels in sensitive individuals (43).

High fiber intakes have also been associated with lower blood pressure (44,45). However, blood pressure is affected by many factors in the diet such as the number of servings of fruits and vegetables in the baseline diet and minerals, including sodium, potassium, calcium, and magnesium (45). How much change is necessary also needs to be agreed upon.

Fiber and satiety

As with the other potential benefits of dietary fiber, a protocol is needed to determine its effect on satiety. This area is particularly challenging, because studies in this area use many different protocols and the results vary. Satiety is frequently measured by subjective measures on visual analogue scales at varying intervals after eating. Fibers often increase satiety ratings, but vehicle (liquid or solid) of fiber delivery, timing, dose, viscosity, and type of fiber all affect the outcome. A feeling of increased satiety may, but does not always, correlate with reduced long-term energy intake or weight loss (46–50). Thus, the role of fiber in weight is contradictory. Determining fibers' effects on hunger-modulating hormones and on the gut microbiome and its role in body weight may lend further understanding in this area (22,51).

Conclusion

The CODEX dietary fiber definition offers opportunities and challenges. The opportunities for international harmonization will be realized only if all countries adopt the footnotes and include oligomers with a DP of 3–9. Proof is needed to show that fibers in CODEX categories 2 and 3, e.g., those that are extracted from edible materials by some means or those that are synthesized or modified, provide a health benefit. Protocols are necessary to ascertain the needed proof. The first step should be an EBR of all data with an emphasis on findings in humans. A critical analysis

of epidemiological studies including strategies should include ways to deal with multiple confoundings and interactions. One possible way to address this is with study designs such as those of Pal et al. (32) that looked at potential synergy of fibers in food with fibers added to food. One confounding issue that needs to be addressed includes a separation of the effects of fiber, especially cereal fiber, from whole grains. Such studies may help with better understanding the role of isolated and intrinsic fibers. For epidemiological studies to be optimally useful, food databases need to be updated to reflect the oligosaccharides with DPs 3–9, resistant starch, and added fibers. Animal studies have long been used for proof of essentiality of vitamins in early nutrition studies. For fiber research, such studies are invaluable for delineating mechanisms. EBRs on the effects of isolated fibers must characterize many attributes of the fiber and carefully specify numerous study characteristics. Data are needed to show that isolated fibers can help fill the fiber gap and improve health outcomes.

Addressing this gap is critical, because usual intakes average 14–15 g/d in the US. Under 10% of the U.S. population meets the recommended fiber intakes. Other countries also ingest well below the recommended amounts. Meeting the dietary fiber requirement with common foods means that the correct number of whole grain and fruit and vegetable servings are needed along with nuts and legumes as recommended by the USDA's MyPlate (52,53). Recommendations by the Dietary Guidelines Advisory Committee to adopt a Dietary Approaches to Stop Hypertension or Mediterranean Eating Pattern or align diets according to MyPlate along with the judicious use of added fibers can address the fiber gap and improve overall nutriture. Nutritionists need to advocate for increasing total fiber and should recommend that it come from a variety of sources, including added fiber. They should direct consumers to the fiber line on the Nutrition Facts panel of the label. Consumers look at the fiber amounts listed on the Nutrition Facts panel and can be reassured that the fiber numbers listed have physiological effects (52). Consumers should strive to ingest a variety of fibers from fruits, vegetables, cereal grains, seeds and nuts, and legumes as well as a variety of isolated fibers in order to reap the benefits and synergies of a mix of fiber types (52). Health professionals and others need to help consumers learn terms on the ingredient statement that identify added fibers (52). For those needing to restrict energy, foods such as whole-grain breads with double fiber can add fiber to the diet without exceeding energy needs while providing an important mix of fiber types and physiological benefits. Thus, foods with added fiber can complement efforts to increase the intake of foods naturally rich in fibers.

The take-away messages for dietary fiber should encourage for consumers to eat more fiber from fiber-rich foods and foods with added fibers to address the fiber gap (52). Messages about the science behind all fiber sources should support the CODEX definition and emphasize the importance of increasing fiber intake and fiber variety while staying within energy needs.

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Appendix: A brief description of the CODEX Alimentarius Commission and its role

The Codex Alimentarius Commission was established in 1961 by the FAO of the United Nations and joined by the WHO to implement the Joint FAO/WHO Food Standards Programme, which The Commission is charged with protecting the health of consumers and facilitating international trade of food through the setting international standards (i.e. Codex Standards). Further, the CAC is an international reference point for the resolution of disputes concerning food safety and consumer protection. Governments belonging to the United Nations or who are associate members of the FAO and/or WHO can participate in the CODEX meetings. Currently there are 192 members.

Various nutrition and food safety standards are discussed and voted on by numerous committees. The CODEX dietary fiber definition came through the CODEX Committee on Nutrition and Foods for Special Dietary Use. Methods of analysis for dietary fiber will go through the CODEX Committee on Methods, Analysis, and Standards.

The Codex Alimentarius (literally "Book of Food") codifies recognized standards, codes of practice, guidelines, and other recommendations relating to foods, food production, and food safety.