

# WHOLE GRAINS

BY THE INTERNATIONAL FOOD INFORMATION COUNCIL

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Grains have been known as the “staff of life” for thousands of years, serving as a vital food source for humans. Today, foods made with whole grains are recognized as important sources of nutrients like fiber, trace minerals, and certain vitamins and phytochemicals that are not restored through traditional grain enrichment and fortification practices. These components are believed to play a key role in reducing risk of disease. Research shows that healthful diets rich in whole grain foods may play a part in reducing risks of heart disease, certain types of cancer and type 2 diabetes. They may also help in managing body weight.<sup>1</sup>

Whole grains are composed of three plant components: the bran, the germ and the endosperm. In the last century, advances in the milling and processing of grains have allowed for the large-scale separation and removal of the bran and germ, resulting in refined flour that

consists only of the endosperm. Refined flour has become popular because it produces baked goods with a softer texture and extended freshness. However, removing much of the bran and germ results in losses of fiber, B vitamins, vitamin E, trace minerals, protein, unsaturated fat and about 75 percent of phytochemicals, which are substances in plant-based foods with physiologically active components that may have functional health benefits. To correct for some of these losses, the process of enrichment began in the early 1940s to restore some B vitamins (thiamin, riboflavin and niacin) and the mineral iron to flour.<sup>2</sup> Since 1998, the U.S. Food and

Drug Administration (FDA) has required enriched grain products to also be fortified with folic acid, the synthetic form of the B vitamin folate, to help women of childbearing age reduce the risk of having a pregnancy affected with a neural tube defect.<sup>3</sup>

The [2015–2020 Dietary Guidelines for Americans \(DGA\)](#) recommend a healthy eating pattern that includes grains, at least half of which are whole grains or roughly three ounce-equivalents per day. A one ounce-equivalent of whole grains (e.g., one slice of 100-percent whole wheat bread) contains 16 grams of whole grains.<sup>1</sup>

## ENRICHMENT VS. FORTIFICATION

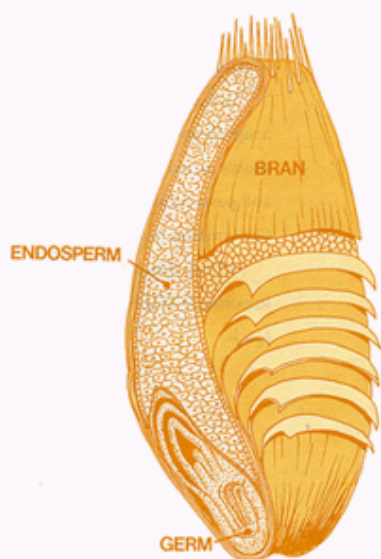
**Enrichment:** the addition of vitamins and minerals to restore nutrients to levels found in a food prior to storage, handling and processing.<sup>4</sup>

**Fortification:** the addition of nutrients that were not originally present in a food or at a different amount than was present in the original food.<sup>3</sup>

## DEFINITION OF WHOLE GRAINS

A whole grain is made up of the intact, ground, cracked, flaked or otherwise processed kernel of the grain plant (composed of the bran, germ and endosperm) after the removal of inedible parts such as the hull and husk.<sup>15</sup> Whole grains can be eaten whole, cracked, split, flaked or ground. Most often, whole grains are milled into flour and used in bread, cereal, pasta, crackers or other grain-based foods. Regardless of how the whole grain is handled, a product may only be declared as “whole grain” if it provides approximately the same ratio of bran, germ and endosperm as found in the original grain.<sup>6,7</sup>

Types of whole grains include wheat, oats, popcorn, brown and wild rice, barley, rye, cornmeal, buckwheat, bulgur (cracked wheat), millet, quinoa, sorghum, and less common sources like triticale, amaranth, emmer, farro and spelt. Whole grains can be found in whole foods like oatmeal, brown rice and popcorn; they can also be ingredients in other foods like breakfast cereals or products made with whole wheat flour.



## ANATOMY OF A WHOLE GRAIN KERNEL

**Bran:** The multi-layered outer skin of the kernel that helps to protect the other two parts of the kernel from sunlight, pests, water and disease. It contains important antioxidants as well as iron, zinc, copper, magnesium, B vitamins, fiber and phytonutrients.

**Germ:** The embryo, which, if fertilized by pollen, will sprout into a new plant. It contains B vitamins, vitamin E, antioxidants, phytonutrients and unsaturated fats.

**Endosperm:** The germ's food supply, which, if the grain were allowed to sprout and grow, would provide essential energy to the young plant. As the largest portion of the kernel, the endosperm contains starchy carbohydrates, proteins, and small amounts of vitamins and minerals.

Diagram source: [http://wbc.agr.mt.gov/Consumers/diagram\\_kernel.html](http://wbc.agr.mt.gov/Consumers/diagram_kernel.html)

## WHOLE GRAIN DIETARY RECOMMENDATIONS AND CURRENT INTAKE

The 2015–2020 DGA describe a healthy eating pattern as one that includes grains, at least half of which are whole grains. For adults eating approximately 2,000 calories per day, the recommendation is to consume about six ounce-equivalents of grains per day, with three ounce-equivalents coming from whole grain sources.<sup>1</sup>

Whole grain intake remains much lower than recommended for many Americans. According to the National Health and Nutrition Examination Survey (NHANES) for 2001–2010, the average intake of whole grains for adults 19 to 50 years old

was 0.61 ounce-equivalents per day, and for adults 51 and older the whole grain intake was 0.86 ounce-equivalents per day (versus a goal of three ounce-equivalents per day based on a 2,000 calorie diet).<sup>8</sup> Whole grain intake increased in 2011–2012 compared with previous values, with adults consuming 0.97 ounce-equivalents per day. During this same time period, 60 percent of adults met the daily recommendations for total grains; however, only eight percent of adults met the daily recommendations for whole grains.<sup>9</sup>



## WHOLE GRAINS AND HUMAN HEALTH

Whole grains are rich in dietary fiber, which is associated with reduced risk for many health conditions. However, some research demonstrates that the health-promoting effects of whole grains are attributed to more than just their fiber content. For example, studies show that in women, even after controlling for fiber intake, the health effects of whole grains on heart disease remain.<sup>10</sup>

The health advantages of whole grains are largely associated with consuming the entire whole grain “package,” which includes vitamins, minerals, essential fatty acids and bioactive phytochemicals. Most of the health-promoting substances are found in the germ and bran fraction of the grain kernel and include resistant starch, oligosaccharides, lignans, phytosterols, phytic acid, tannins, lipids, and antioxidants such as phenolic acids and flavonoids.<sup>10</sup>

Although some of the research has focused on individual components of whole grains (like fiber or antioxidants), epidemiological data suggest that whole grain foods offer protection against a range of diseases that is greater than seen with individual food components and phytochemicals in whole grains.<sup>10</sup>

It is important to note that a food that is high in fiber is not necessarily a good source of whole grains, and vice versa. The fiber content of different whole grain foods can vary considerably, ranging between 0.6 grams and 2.9 grams (per 16 grams of whole grain) per serving.<sup>11</sup> Some grain foods that contain a significant or high amount of fiber may not contain meaningful amounts of whole grain. For example, oat bran or high fiber bran cereals may contain very little or no whole grain but provide high levels of fiber because they are made with only the bran portion of the grain.



## CARDIOVASCULAR HEALTH

Research demonstrates an association between consuming whole grains as part of a low-fat diet and a reduced risk of heart disease. Studies have consistently found that individuals with three or more servings of whole grain foods per day have a 20 to 30 percent lower risk for atherosclerotic cardiovascular disease compared to individuals with lower intakes of whole grains. For example, in the Harvard-based Nurses' Health Study, women who consumed two to three servings of whole grains per day were 30 percent less likely to suffer a heart attack or die from heart disease over a 10-year time span compared with women who ate zero to one serving of whole grains per week.<sup>12</sup>

Researchers have also observed that diets rich in whole grain foods tend to decrease low-density lipoprotein (LDL) cholesterol (i.e. the “bad” cholesterol), triglycerides and blood pressure, and increase high-density lipoprotein (HDL) cholesterol (i.e. the “good” cholesterol).<sup>13</sup> Potential mechanisms for this health effect have been proposed but are not fully understood. Components of some whole grains, including soluble fiber such as beta glucan, alpha-tocotrienol and the arginine:lysine ratio, are believed to play a role in lowering blood cholesterol. Whole grains may decrease risk of heart disease through their antioxidant content. Other bioactive components are believed to play a role in vascular reactivity, clotting and insulin sensitivity.<sup>10,14</sup>

## WEIGHT MANAGEMENT

Whole grains may support weight management by enhancing satiety, resulting in lower energy intake, prolonging gastric emptying to delay the return of hunger and increasing insulin sensitivity to lower insulin demand.<sup>14</sup> Evidence suggests that eating more whole grains may not directly lead to weight *loss*, but that whole grain consumption may contribute to *maintaining* a healthy weight.

Studies show that people who include whole grains as part of a healthful diet are less likely to gain weight over time. In a 12-year study, women who had the greatest increase in whole grain food consumption (+0.9 servings per day) versus those with a decrease in consumption (-0.6 servings per day) gained less weight and had 19 percent lower odds of developing obesity.<sup>12,14,15</sup> In men, whole grain and bran intake were independently related to less weight gain. In addition, whole grain intake is inversely associated with potential plasma biomarkers of obesity, including insulin, C-peptide and leptin.<sup>16</sup>

Randomized controlled trials studying the effect of whole grain intake on markers of obesity have shown mixed results. A 2019 systematic review and meta-analysis found that whole grain consumption did not change body weight, body mass index, waist circumference or measurements of body fat as compared to control foods or eating patterns.<sup>17</sup>

## CANCER PREVENTION

Whole grains appear to be associated with a reduced risk of several different types of cancers. Results from a review of 40 case-control studies of 20 different types of cancer found that the pooled odds ratio for cancer in those with high versus low whole grain intake was 0.66 (95% CI, 0.60 - 0.72)<sup>18</sup>, meaning that those who were classified as having high whole grain intake (generally meaning habitual adequate intake of whole grains) had a 34 percent lower risk of cancer than those with lower whole grain intakes, who consumed whole grains infrequently or not at all.<sup>19</sup>

The World Cancer Research Fund and the American Institute for Cancer Research have declared that there is strong evidence that consuming whole grains decreases the risk of colorectal cancer.<sup>20</sup> An analysis based on the results of six cohort studies noted a 17 percent reduction in risk of colorectal cancer with an intake of 90 grams of whole grains daily.<sup>21</sup> In addition, a 15-year-long prospective cohort study of more than 61,000 Swedish women noted that those who consumed more than four-and-a-half servings of whole

grains per day had a 35 percent lower risk of colon cancer compared to those who consumed fewer than one-and-a-half servings of whole grains each day.<sup>22</sup> Higher intakes of whole grains have also been associated with decreased risk of gastrointestinal tract cancers, including cancers of the mouth, throat, esophagus, stomach, colon and rectum.<sup>22-24</sup>

Whole grain foods may reduce the risk of cancer by a variety of mechanisms related to the vitamins, minerals, fiber and other beneficial compounds that are primarily found in the bran and germ of the grain kernel.<sup>18</sup> Fiber and certain starches found in whole grains ferment in the colon to help reduce transit time and improve gastrointestinal health. Whole grains contain antioxidants that may help protect against oxidative damage, which may play a role in cancer development. Other bioactive components may affect hormone levels and possibly lower the risk of hormone-dependent cancers. Certain components of whole grains may also bind to carcinogens, which offers a protective effect against cancer.





## GLYCEMIC HEALTH

The [American Diabetes Association Guidelines for the Prevention and Treatment of Diabetes](#) recognize the role of whole grains and fiber in reducing the risk of diabetes and maintenance of blood glucose levels.<sup>25</sup>

A recent meta-analysis of eight large prospective cohort studies, which included 385,868 participants, found that high intakes (at least two to three servings per day) versus low intakes (less than one serving) of whole grains were associated with a significant reduction in the risk of developing type 2 diabetes mellitus. Specifically, the consumption of three daily servings of whole grain foods was associated with a 32 percent lower risk of diabetes.<sup>23,26</sup>

Furthermore, evidence from observational studies and clinical trials suggests improved blood glucose control in people with diabetes who consume whole grains.<sup>27</sup> In people without diabetes, whole grain intake may lower fasting insulin levels and decrease insulin resistance.<sup>28,29</sup>

Components of whole grains, including magnesium, fiber, vitamin E, phytic acids, lectins and phenolic compounds, are believed to contribute to risk reduction of type 2 diabetes as well as lowering blood glucose and blood insulin levels. Additionally, the complexity of the whole grain structure makes it more difficult for the body to digest, which can beneficially slow the release of glucose from the starch in the endosperm, consequently aiding in blood glucose management.



## GASTROINTESTINAL HEALTH

Components of whole grains, including fiber, resistant starch and oligosaccharides, play roles in supporting gastrointestinal health. Studies suggest that dietary fiber from whole grains such as wheat and oats increases stool weight.<sup>30</sup> The increase in stool weight is caused by the presence of fiber, water that the fiber holds and partial fermentation of fiber and oligosaccharides, which increases the amount of persistent bacteria in stool.<sup>23</sup>

The large intestine responds to the larger and softer mass of residue produced by a higher-fiber diet by contracting, which speeds the movement of the bowel contents towards excretion. The effect of promoting normal intestinal regularity makes whole- and high-fiber grain products integral components of diet plans to help alleviate constipation and decrease the risk of developing diverticulosis and diverticulitis.<sup>30</sup>



## STRATEGIES FOR INCREASING WHOLE GRAIN INTAKE

- Read food labels and ingredients lists to look for the words “whole grain” or “whole” before a grain’s name—for example, “whole wheat” or “100% whole grain.”
- Be wary of phrases like “multi-grain,” “stone-ground,” “100% wheat,” “seven grain,” or “bran.” Foods labeled in this way are usually not whole grain.
- Look for the [Whole Grain Stamp](#) on food packages.
- As much as possible, substitute a whole grain product for a refined grain product. For example, choose brown or wild rice instead of white rice, or whole wheat bread in place of white bread.
- Choose a whole grain breakfast cereal or oatmeal for breakfast.
- Have popcorn or a whole grain granola bar as an afternoon snack.
- Experiment with new-to-you whole grains: combine cooked millet, quinoa or barley with vegetables, herbs and greens to make a nutrient-packed salad.

## FINDING WHOLE GRAIN FOODS

In general, a serving of grain is an ounce-equivalent of food, such as a slice of bread; a half-cup of cooked cereal, rice or pasta; or about 1 cup of dry cereal (one-quarter cup for dense, granola cereals to one-and-a-half cups for some unsweetened puffed cereals). At least three ounce-equivalents of whole grains per day are necessary to achieve the Dietary Guidelines for Americans recommendation to consume half of all grains as whole grains.

Currently, the amount of whole grain present in a food product is allowed as a voluntary declaration but is not required. Although the number of whole grain food choices is growing, consumers often believe they can identify whole grain products by name, color or fiber content. Additional label reading is required to correctly identify foods that qualify as whole grain. Organizations like the Whole Grains Council have developed packaging symbols, including the [Whole Grain Stamp](#), to help consumers identify products containing whole grains. Other factors to consider when identifying whole grain products include:

### Product Name

To verify that a product is whole grain, consumers are encouraged to look beyond a product's name. Descriptive words in the product's name, such as "stone-ground," "multi-grain," or "100 percent" wheat or bran, do not necessarily indicate that a product is whole grain. Instead, words to look for include "whole grain" or "100 percent whole wheat."

### Color and Texture

The color of a food does not determine whether it is a whole grain. For example, bread may be brown because molasses or caramel coloring has been added. Many whole grain products, such as ready-to-eat cereals, are light in color. Also, whole grain foods are not always dry or gritty; some whole grain foods may be dense with a pleasant "nutty" flavor or light and flaky like a cereal grain.

### Fiber Content

The amount of fiber in a whole grain food varies depending on the type of grain, amount of bran, density of the product and moisture content. So, some whole grain foods may not be a "good" or "excellent" source of fiber. Labeling regulations allow a food to be called a good source of fiber if the food contains 2.5 to 4.9 grams of fiber per serving; an excellent source if it contains 5.0 grams or more per serving.<sup>31</sup> The current 2.5-gram benchmark is based on meeting 10 percent of a 25-gram daily value for fiber. Beginning in 2020, label reform from the FDA will increase the parameter for qualifying as a "good source" to 2.8 grams of fiber per serving, which is 10 percent of 28 grams.

### Ingredient Statement

The ingredient statement will list whole grains by the specific grain, such as whole wheat flour, whole oats or whole grain corn. The phrase "whole grain" or "whole" will appear before the grain's name. In many whole grain foods, a whole grain is among the first ingredients listed. Foods made with several different whole grains noted farther down on the list of ingredients may also qualify as a whole grain food. However, the ingredient list does not clearly indicate the amount of whole grain present in the food, nor does "whole grain" appear on the Nutrition Facts label.



### Health Claims

Based on FDA regulations, a food manufacturer may choose to include a health claim that links a diet rich in whole grains to reduced risk of heart disease and some types of cancer. To qualify for this claim, a product must contain all portions of the grain kernel, contain at least 51 percent whole grain by weight per reference amount customarily consumed, and meet specified levels for fat, cholesterol and sodium. A health claim might read, "Diets rich in whole grain foods and other plant foods and low in total fat, saturated fat and cholesterol may help reduce risk of heart disease and certain cancers."



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