



# Gluten-Free Diet: Is this Diet for You?

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The gluten-free diet and gluten-free foods have recently gained tremendous popularity in the media and food industry. Gluten-free food labeling is quickly becoming one of the most common product-related claims, with 11% of all new foods and beverages claiming gluten-free health and nutrition labeling in 2010.<sup>1</sup> However, gluten-free foods are being misunderstood as healthier for the general public or beneficial to weight loss.<sup>2,3</sup> If a product is gluten-free, this does not mean it is fat-free nor has fewer calories. In fact, gluten-free products may contain more calories and a higher fat content than their gluten-containing counterparts, with no additional nutritional health benefits.<sup>4</sup> The small

minority of the population with celiac disease—a genetic autoimmune disorder in which gluten damages the small intestine—must avoid consuming gluten or face long-term health complications, but for most, adopting a gluten-free diet may not be providing any health benefits. Understanding your true dietary needs is important, and you should discuss any changes in diet with your physician before restricting certain foods or food groups. This article provides information about gluten, the gluten-free diet and food choices, who should follow the gluten-free diet, and the inclusion of gluten as part of a healthy diet.

# Gluten

## What is gluten?

Gluten is a protein found in grains (see Figure 1), such as wheat, barley, and rye.<sup>5</sup> Gluten gives foods a chewy texture. It is commonly found in breads, cereals, and pastas, along with many other unexpected foods such as some candies, licorice, and soy sauce.<sup>2</sup> Some restaurants add gluten-containing ingredients to eggs and other foods to provide thickness or change the texture.

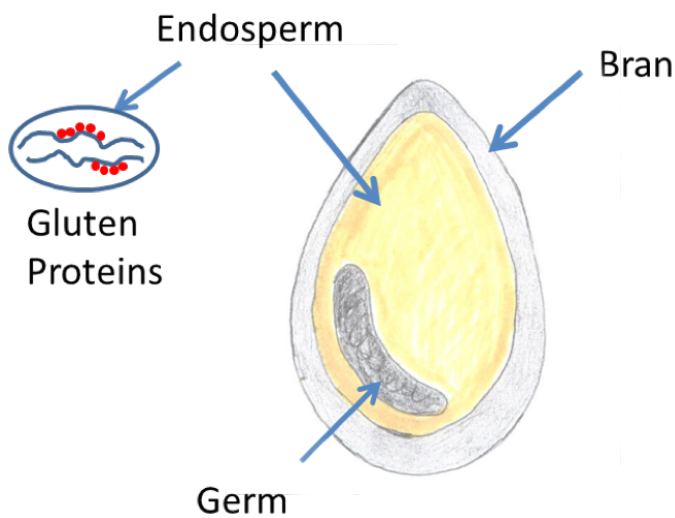


Figure 1. Gluten proteins are mainly found in the endosperm of a grain.

## Which foods contain gluten?

Gluten is found in grains and common foods that are made with wheat such as bread, cookies, and pasta. However, gluten is also found in a wide range of other products including: processed foods, medicines, dietary supplements, lip balms, cosmetics, and stamp glues.<sup>5</sup> With the recent popularity of the gluten-free diet, many grocery stores are beginning to sell specialty gluten-free labeled items. Any product that claims to be gluten-free should not have wheat, barley, or rye listed in the ingredients on the label. Check the packaging, labels, and nutritional information to ensure a food is gluten-free.

Table 1. Example of gluten-free foods  
(Adapted from National Institute of Diabetes and Digestive and Kidney Diseases<sup>5</sup>)

Examples of Gluten-Free Foods				
Vegetables – All vegetables are naturally free of gluten				
Avocado	Broccoli	Cabbage	Carrots	Celery
Corns (fresh or frozen)	Cucumber	Garlic	Kale	Lettuce
Peas (fresh or frozen)	Okra	Onion	Potatoes	Squash

Checking the nutritional information of packaged foods is always a good idea, regardless of dietary restrictions or needs. Foods that naturally do not contain any gluten, such as fruits, beans, nuts, and rice, are gluten-free foods, but might not explicitly state that on their labels in grocery stores. Figure 2 illustrates the gluten-free product labeling commonly found in most grocery stores. Table 1 is a list of gluten-free foods (examples from each food group) and Table 2 lists common gluten-containing foods or ingredients that may contain gluten.



Figures 2. Examples of gluten-free labeling on food products

Table 1. (Continued) Example of gluten-free foods

Fruits – All fruits are naturally free of gluten				
Apples	Bananas	Blueberries	Dates	Grapes
Oranges	Pears	Pineapples	Strawberries	Watermelons
Meats, Other Proteins – Meats are gluten free unless processed or fried with breadcrumbs				
Beef	Chicken	Lamb	Pork	Turkey
Bacon*	Beans	Eggs	Fish & Shellfish	Tofu
Dairy Products				
Butter*	Cheese	Cottage cheese*	Cream	Cream cheese*
Ice Cream*	Milk*	Sour cream	Whey protein	Yoghurt*
Nuts and Seeds – Flavored nuts and seeds may contain gluten				
Almond	Cashew	Peanuts*	Pistachio	Walnuts
Chia seeds	Flax seeds	Pumpkin seeds	Sesame seeds	Sunflower seeds
Gluten-free Grains				
Amaranth	Buckwheat	Millet	Oats*	Quinoa
Rice	Sorghum	Teff	Tapioca	Wild Rice
Condiments				
Honey	Jams, Jellies	Ketchup	Mayonnaise*	Mustard*
Pepper	Salt	Spices	Sugar	Vinegars
Beverages				
Coffee	Fruit juices	Soda	Tea	Water

\* May contain gluten – Check a food label

Table 2. Common foods/ingredients that may contain gluten-containing foods  
(Adapted from National Institute of Diabetes and Digestive and Kidney Diseases<sup>5</sup>)

Common Foods/Ingredients that may contain gluten				
Grains/Flour				
Barley	Bran	Couscous	Durum flour	Faro
Oats**	Rye	Self-rising flour	Wheat flour	White flour
Starches				
Cereals	Cream of wheat	Bread	Cakes	Cookies
Crackers	Donuts	Macaroni	Muffins	Pasta
Pastries	Prepared Mixes	Pretzels	Spaghetti	Stuffing

Table 2. (Continued) Common foods/ingredients that may contain gluten-containing foods

Meat Substitutes				
Hot Dogs	Luncheon Meats	Sausages	Imitation seafood	Veggie burgers
Seasoning, Soup & Sweets				
Casseroles in white sauce	Creamed Soup	Dips	Fried foods	Gravy
Gumbos	Malt Syrup	Malt Vinegar	Pie Crusts	Soy sauce
Miscellaneous				
Chewing gums	Instant Coffee/Tea	Laxatives	Make-up (lipstick)	Vitamins

## Gluten Sensitivity and Gluten-Free Diet

### *The gluten-free diet*

A gluten-free diet eliminates the protein gluten from the diet. A gluten-free diet is recommended for those with celiac disease, and for people who are sensitive to gluten with a condition called non-celiac gluten sensitivity (NCGS). Emerging research suggests there is a wide range of NCGS disorders that improve after following a gluten-free diet, including irritable bowel syndrome.<sup>5-7</sup> A gluten-free diet has also been shown to have positive effects for people with wheat allergy and FODMAP (Fermentable Oligo-, Di- and Mono-saccharides, and Polyols) sensitivity.<sup>7</sup> Many conditions may benefit from adopting a gluten-free diet (see below), but more research is necessary to completely understand the underlying causes and possible treatment options.



Figure 3. A gluten-free diet does not include regular pasta or bread, unless labeled “gluten-free”

**WHEAT ALLERGIES** may be involved in a number of different conditions or disorders. Wheat contains two major components: proteins and carbohydrates. Although gluten is the primary protein in wheat, it contains many other proteins as well; any of these could be the cause of symptoms usually associated with gluten sensitivity and NCGS if there is an allergy to that specific protein. Since the gluten protein is a primary component of wheat, a gluten-free diet may benefit those with a wheat allergy because by avoiding gluten, the other wheat components can be avoided. However, it is highly possible that different proteins or other distinct components of wheat could cause wheat allergy.<sup>7</sup>

### *What is celiac disease?*

Celiac disease is a genetic condition, meaning it is passed down to children through parents’ DNA that affects the immune system. Approximately two million people in the United States, less than 1% of the population, suffer from celiac disease.<sup>5,8</sup> Normally, a person’s body produces enzymes to break down foods containing gluten. However, in a person with celiac disease, gluten triggers an immune response that harms and inflames the digestive tract. When someone suffering from celiac disease consumes gluten, the immune response specifically damages finger-like structures in the small intestines called villi, which absorb the nutrients from food that nourish the body. Damage to the villi in the small intestines can lead to malnourishment, because the body is unable to properly absorb nutrients without functioning villi. Removing gluten from the diet allows the body to heal itself and can reverse damage to the intestinal villi. Symptoms of celiac disease are variable, including diarrhea, bloating, fatigue, malnutrition, cramping, vomiting, and constipation.<sup>5,6</sup>

The longer an individual suffering from celiac disease goes undiagnosed and untreated, the greater the possibility of developing serious health problems, such as anemia, osteoporosis, skin rash, infertility, and neurological conditions

due to nutrient malabsorption. Physicians may use a celiac blood test and endoscopic biopsy from multiple areas of the intestine to test for celiac disease. The diagnosis may be confirmed if the patient improves while following a gluten-free diet. The treatment of celiac disease is lifelong adherence to a strict gluten-free diet.<sup>5,6</sup>

### *What is Non-Celiac Gluten Sensitivity (NCGS)?*

Although NCGS may be similar to celiac disease in symptoms, they are not the same thing. A person suffering from gluten sensitivity does not damage their intestinal villi by eating foods containing gluten, unlike celiac disease, but consuming gluten may produce similar immediate symptoms in both cases. Symptoms of NCGS can be similar to celiac disease or irritable bowel syndrome, and may include a wide variety of lesser understood indications, such as fatigue, headache, anxiety, sleep abnormalities, discomfort, dull ache, skin rash, acid reflux, aphthous stomatitis (canker sores – round, small mouth sore), anemia, depression, asthma and rhinitis (hay fever). To diagnose NCGS, a physician must first be certain the symptoms are not caused by any other established gluten or wheat disorders, such as wheat allergy, celiac disease, or manifestations of celiac disease that occur in the skin (dermatitis herpetiformis) or brain (gluten ataxia).<sup>7</sup>

Gluten sensitivity is a condition that may be caused by several different gluten or wheat disorders, or it may originate from an unknown cause. More research is necessary to understand the cause and solution for gluten sensitivity.<sup>7,9</sup> For those who suffer from gluten sensitivity, the best treatment option is a gluten-free diet to eliminate the offending protein. A physician should always be contacted for diagnosis and treatment prescription, including adopting a new diet plan.

### *What are Non-Celiac Gluten-Related Disorders (NCGRD)?*

Only a fraction of people who self-report NCGS have a condition related to the actual gluten protein. Individuals not diagnosed with celiac disease or NCGS may have FODMAP intolerance or a wheat allergy. Indications of NCGRD include the celiac-like symptoms of NCGS, such as diarrhea, bloating, fatigue, malaise, cramping, vomiting, and constipation, or a wide variety of other symptoms.<sup>7,9</sup>

**Fermentable Oligo-, Di- and Mono-saccharides, and Polyols (FODMAP) intolerance** has been noted to induce symptoms of irritable bowel syndrome (IBS) in some patients. FODMAPs are short-chain carbohydrates (commonly found in wheat and dairy), such as lactose, fructose and sorbitol, and fructo-oligosaccharides and galacto- oligosaccharides – all are carbohydrate naturally found in foods. FODMAPs can be incompletely absorbed in the small intestine; entering the large intestine intact, they then draw water out of the body, leading to diarrhea, and can also be fermented by

bacteria, causing gas and bloating. Lactose-intolerance is a form of specific FODMAP intolerance. The ways in which FODMAPs may contribute to NCGRD and other disorders needs further exploration, but those suffering from digestive and dietary-related symptoms may also benefit from a gluten-free/restricting or FODMAP-restricting diet.<sup>7</sup>

### *Irritable Bowel Syndrome (IBS) and Gluten*

NCGS may be extended to IBS, as well. Recent evidence shows that gluten may be a trigger for IBS. Wheat is already included as a food known to induce symptoms of IBS. Some studies have suggested that a diet with gluten free or reduced amount of gluten may improve IBS patient symptoms such as digestive discomfort or fatigue.<sup>7,10</sup> Also, the IBS patients in the United States may find avoiding gluten in their diets is easier to follow because of availability of gluten-free foods and it is less restrictive diet compared to other diets.<sup>11</sup> The connection between IBS and gluten requires further research to determine a cause or correlation. Future studies may explain the perceived symptoms of IBS in conjunction with gluten consumption and expand on the current knowledge and treatment options. Those who recognize gluten as a dietary cause of IBS symptoms may benefit from adopting a gluten-free or gluten-reduced diet.<sup>5</sup>

## **The Gluten-Free Label and Standards**

### *What does the label mean?*

The U.S. Food and Drug Administration (FDA) has defined standards for using the term “gluten-free” on food labeling.<sup>12</sup> The final criteria, issued in 2013, ultimately mandates that a product must contain less than 20 parts per million (ppm)\* of gluten or 20 mg of gluten per 1,000,000 mg of food in order to be labeled “gluten-free”. The product also must not contain any gluten-containing grains/ingredients or ingredients derived from gluten-containing grains without processing to eliminate gluten, or it must naturally not contain gluten and have a demonstrated concentration of less than 20 ppm. If a gluten-free labeled product contains an amount of gluten greater than 20 ppm, the product is considered misbranded. Incorrect labeling of gluten-free foods could lead to harmful consequences for people suffering from celiac disease, wheat allergies, or other conditions like NCGS and NCGRDs. Some studies report that patients with celiac disease may be able to tolerate the ingestion of gluten in levels lower than 20 to 50 ppm per day. However, any amount of gluten could still exacerbate the symptoms of celiac disease and lead to intestinal damage and discomfort or further complications.<sup>13</sup>

\* PPM is a unit of measure that indicates a unit of the item of interest in a total of 1 million units overall. 20 ppm of gluten means 20 mg of gluten in 1,000,000 mg = 1 kg of foods. A slice of wheat bread contains about 4 grams of gluten. At a level of 20 ppm, 4 grams of gluten would be contained in 200 kg (~440 pounds) of wheat bread.

## Gluten contamination

There are several means by which a food product may become contaminated with gluten. However, studies conflict on the prevalence of gluten contamination above the FDA allowed standards. Gluten contamination may originate from the use of other gluten-containing ingredients in the manufacturing process or cross-contact. Several studies reported 14-22% of naturally gluten-free foods were cross-contaminated.<sup>14, 15</sup> Since naturally gluten-free crops, such as rice and corn, may not be tested for gluten, contamination from other gluten-containing crops can easily occur. In fact, cross-contamination may occur when crops are grown, harvested, processed, or at any other step in the farm-to-table food chain.<sup>13</sup> Although estimates vary, gluten-free labeled products sold in the US maintain a low prevalence of gluten contamination and mislabeling. Several studies found that 96-99% of products branded as gluten-free are fully compliant with the FDA regulations, and contain less than 20 ppm of gluten.<sup>13</sup>

## Is A Gluten-Free Diet for You?

If you suspect you may have celiac disease or gluten sensitivity, you should consult a physician. It is particularly critical to have a screening for celiac disease as early as possible due to its debilitating nature if a gluten-free diet is not strictly adhered to. Those with type 1 diabetes should be extra cautious when experiencing any symptoms associated with celiac disease or gluten sensitivity because celiac disease is 4 to 6 times more prevalent in those with type 1 diabetes. Those with both conditions have an increased risk of anemia, osteoporosis, fractures, and mortality with cardiovascular diseases. Adopting a gluten-free diet has been shown clinical improvements in patients with type 1 diabetes with celiac disease.<sup>16</sup>

On the other hand, without a medical condition requiring a gluten-free diet, it may be harmful to restrict essential components of a healthy, balanced diet found in gluten-containing foods. Some of the risks and drawbacks of a gluten-free diet include: (1) deficient nutritional intake of folate, thiamine, and fiber, (2) decreased intake of calcium, iron, and zinc, (3) malnutrition, (4) possible increased intake of fat and sugar, (5) risk of eating disorders, and (6) greater food expense (gluten-free labeled foods may be more expensive than gluten-containing alternatives). Instead of adopting a gluten-free diet for weight loss, it would be more beneficial to learn about correct proportions and recommended daily values of protein, carbohydrates, produce, and dairy for weight loss or management. Consuming the right amounts of these healthy nutrients reduces risk factors for obesity, diabetes, and many other diseases and conditions.<sup>1,4,7,9</sup>

## Gluten-Free Recipe

It may seem challenging to find healthy meals and foods that are gluten-free, but many tips and alternatives have been developed to make almost any dish gluten-free. For example, many grocery stores stock specialty gluten-free or vegetable pastas. Even baked goods, such as breads, muffins, and cakes, can be made gluten-free by replacing white flour with a nut or bean flour (such as almond, coconut, or soy flour) with other gluten-free modifications. Since fruits and vegetables do not contain gluten, using more produce, or baking alternatives involving produce, is a great way to create gluten-free meals.

The recipe below was adapted from the popular French dish ratatouille. This dish blends the flavors of fresh, savory vegetables that can be found locally and a bold French flair to create a healthy and hearty gluten-free meal. With about two to three cups of vegetables per serving, this gluten-free dish packs a nutritious punch. Try it alone, with added protein, or as a side dish in your favorite healthy meal.

### Ratatouille

**Prep time:** 50 minutes

**Makes** 4-6 servings

**Total cost:** \$10-14\*, Per serving: about \$2.40

\*adding egg, chicken, or chesses

#### Ingredient:

1 large eggplant, sliced into discs

1-2 large squash or zucchini (or both), sliced into discs

2 14-ounce can diced tomatoes



- 1 large onion, sliced into discs
- 2-3 large tomatoes, sliced into discs
- 2 teaspoons garlic, minced (about 4 cloves or 1 teaspoon garlic powder)
- 2 tablespoons Italian seasoning
- Salt and pepper, to taste
- Optional, 2 teaspoons red pepper flakes
- Optional, 2 teaspoons chili powder
- Optional, 2 tablespoons parmesan cheese per serving

**Directions:**

1. Wash hands with soap and running water, rinse, and then dry hands with a clean towel.
2. Preheat oven to 375 degrees Fahrenheit. Grease a casserole dish.
3. Thoroughly wash the eggplant, squash, and tomatoes and cut into round discs. Also slice the onion into round discs.
4. Spread one can of diced tomatoes onto the bottom of the casserole dish to form an even layer.
5. Place the sliced discs of vegetables (eggplant, squash, tomato, and onion) in uniform lines on top of the tomato layer. (See below)
6. Sprinkle the vegetables with garlic, Italian seasoning, salt, pepper, and any additional seasonings desired.
7. Bake approximately 45-60 minutes, or until the vegetables are tender.



**Optional:**

Add a fried egg, cooked chicken, or sprinkle with parmesan cheese on top of the ratatouille for extra protein.

**Per serving:**

Calories: 101, Carbohydrates: 23g, Fat: 1g, Protein: ~6g (adding a fried egg), Dietary Fiber: 8g, Total Sugars: 12g

**References**

1. Sharma, G.M., Pereira, M., & Williams, K.M. (2015). Gluten detection in foods available in the United States - a market survey. *Food Chemistry*, 169, 120-126.
2. Procter, S & Dixon, K.N. (2015). Gluten and Your Gut's Good Health. *Kansas State University, Research and Extension Fact Sheet*. Available at: <https://www.k-state.edu/fcs/agent-resources/lesson-series/fcs-lesson-series/MF3226%20Gluten%20and%20Your%20Guts%20Good%20Health%20Fact%20Sheet.pdf>
3. Bastin, S., Mullins, J., Workman, L., & White, L. (2012). The Gluten-Free Choice: Is it for me? *University of Kentucky, College of Agriculture*. Available at: <http://www2.ca.uky.edu/agcomm/pubs/fcs3/fcs3564/fcs3564.pdf>
4. Missbach, B., Schwingshackl, L., Billmann, A., Mystek, A., Hickelsberger, M., Bauer, G., & König, J. (2015). Gluten-free food database: the nutritional quality and cost of packaged gluten-free foods. *Peer Journal*, 3, e1337.
5. *National Institute of Diabetes and Digestive and Kidney Diseases*. (2015). Celiac Disease. Available at: <http://www.niddk.nih.gov/health-information/health-topics/digestive-diseases/celiac-disease/Pages/facts.aspx#top>
6. *National Institute of Health Medline Plus*. (2015). Celiac Disease. Available at: <http://www.nlm.nih.gov/medlineplus/celiacdisease.html>
7. De Giorgio, R., Volta, U., & Gibson, P.R. (2016). Sensitivity to wheat, gluten and FODMAPs in IBS: facts or fiction? *Gut*, 65(1), 169-178.
8. Rubio-Tapia, A., Ludvigsson, J.F., Brantner, T.L., Murray, J.A., & Everhart, J.E. (2012). The prevalence of celiac disease in the United States. *The American Journal of Gastroenterology*, 107(10), 1538-1544.
9. Catassi, C., Bai, J. C., Bonaz, B., Bouma, G., Calabrò, A., Carroccio, A., Castillejo, G., Ciacci, C., Cristofori, F., Dolinsek, J., Francavilla, R., Elli, L., Green, P., Holtmeier, W., Koehler, P., Koletzko, S., Meinhold, C., Sanders, D., Schumann, M., Schuppan, D., Ullrich, R., Vécsei, A., Volta, U., Zavallos, V., Sapone, A., & Fasano, A. (2013). Non-celiac gluten sensitivity: the new frontier of gluten related disorders. *Nutrients*, 5(10), 3839-3853.
10. Vazquez-Roque, M.I., Camilleri, M., Smyrk, T., Murray, J.A., Marietta, E., O'Neill, J., Carlson, P., Lamsam, J., Janzow, D., Eckert, D., Burton, D., & Zinsmeister, A.R. (2013). A controlled trial of gluten-free diet in patients with irritable bowel syndrome-diarrhea: effects on bowel frequency and intestinal function. *Gastroenterology*, 144 (5): 903-911.
11. DeWeerd S. (2016). Diet: Food for thought. *Nature*, 533 (7603): S108-S109.

12. U.S. Food and Drug Administration, U.S. Department of Health and Human Services. Gluten-Free Labeling of Foods. (Updated 05/06/2016). Available at: <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/Allergens/ucm362510.htm>
13. Lee, H.J., Anderson, Z., & Ryu, D. (2014). Gluten Contamination in Foods Labeled as "Gluten Free" in the United States. *Journal of Food Protection*, 77 (10), 1830–1833.
14. Thompson, T., Lee, A.R., & Grace, T. (2010). Gluten contamination of grains, seeds, and flours in the United States: a pilot study. *Journal of American Dietetic Association (Journal of Academy of Nutrition and Dietetics)*, 110(6):937-940.
15. Thompson T. (2004). Gluten contamination of commercial oat products in the United States. *New England Journal of Medicine*, 351(19):2021-2022.
16. DeMelo, E. N., McDonald, C., Saibil, F., Marcon, M. A., & Mahmud, F. H. (2015). Celiac disease and type 1 diabetes in adults: Is this a high-risk group for screening? *Canadian Journal of Diabetes*, 39(6), 513-519.

## Abstract

With the growing popularity of the gluten-free diet, there are many misconceptions surrounding gluten, carbohydrates, celiac disease, and gluten-sensitivity. This article explains the definitions and differences between celiac disease, gluten-sensitivity, and other gluten-related conditions. The article also addresses the risks of adopting a gluten-free diet without a medical necessity to do so. Lastly, the article provides a healthy gluten-free recipe.



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