

Grains in Relation to Celiac (Coeliac) Disease

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Here, I present my assessment of celiac disease in relation to cereal grains. What I have to say is based on many years of research in the area of gluten proteins as they relate to celiac disease, but because of the complexity of the subject, I do not claim definitive knowledge. My conclusions do not necessarily represent those of the Agricultural Research Service, United States Department of Agriculture (USDA), and are not intended to define USDA policy. There is much to be learned about celiac disease and some of my conclusions based on current knowledge may be modified as new information develops. In other words, some things I say here might turn out to be incorrect. Finally, I am a research chemist, not a physician, and do not intend this essay to be taken as medical advice in any legal sense.

Celiac disease (*coeliac* is the usual spelling in Europe and Australia) is a condition that may develop in certain genetically susceptible individuals. People with celiac disease cannot eat wheat, rye, or barley. Proteins in these grains (and peptides derived from the proteins during digestion) initiate pathophysiological processes that may eventually lead to severe damage to the absorptive epithelium lining the small intestine. It appears likely that celiac disease is initiated by a mechanism involving immune response, but this has not been proved beyond any question. Certainly, immune reactions become involved after initiation.

Because almost all nutrients, vitamins, minerals, amino acids, carbohydrates, and so on are absorbed by way of the small intestine, malabsorption resulting from damage to the absorptive lining of the small intestine can have wide ranging consequences; weight loss, osteoporosis, neuropathy, and so on. There is a wide range in response among those with celiac disease—some may have only minimal changes in the intestinal epithelium and no obvious symptoms, others may have severe damage to the lining of the intestine and severe symptoms. Although poor digestion of food usually leads to diarrhea, one of the most common symptoms in celiac disease, patients presenting with constipation have been reported.

Although there is a definite genetic component, celiac disease is apparently a multigene disease, and its inheritance is not completely understood. It has been strongly associated with European populations and may be rare in African blacks or Asians of Chinese or Japanese descent. There is a strong correlation with certain histocompatibility antigens, but some people with the suspect antigens show no evidence of celiac disease.

Although some people manifest evidence of celiac disease in the first year of life shortly after the introduction of gluten into the diet, others experience the onset of disease manifestations later in life—even very late in life. Consequently, it has been hypothesized that some environmental factor is likely to be involved in triggering the disease. Candidates for this environmental factor are viral infection, parasite infection (*Giardia?*, *Cryptosporidium?*, *Eimeria?*), surgery, childbirth, even the stress of giving up smoking—these suggestions are highly speculative.

The manifestations of celiac disease are initiated (and re-initiated) in susceptible individuals upon eating wheat, rye, or barley, or any products from these grains that contain the main storage proteins of these grains. Both the proteins themselves and relatively [small peptides](#) derived from the proteins by enzymatic digestion are active in celiac disease. Accordingly, testing for intact proteins rather than peptides derived from them will often be ineffective. Celiac disease may be signalled by the presence of antibodies to gliadins or to endomysium in the blood serum and there are a number of commercial testing centers that provide testing for these antibodies. These tests are valuable, but do not provide complete certainty—either in indicating celiac disease or in indicating its absence.

The presence of antigliadin or anti-endomysium antibodies will frequently result in a recommendation by the diagnosing physician to proceed to the most generally accepted test, intestinal biopsy. In severe cases, the biopsy will show mucosal damage, indicated especially by a flattening of the surface and loss of villous structure. Even this latter test is not entirely specific. A flattened mucosa may be the consequence of a few other diseases and damage may be patchy. The tiny tissue sample excised from the intestine in the biopsy procedure might by chance be taken from a relatively normal patch. To eliminate false negative histological results, the latest recommendation is to obtain 4-5 biopsies from different spots in the small intestine. The earliest stages of the disease may be subtle, perhaps indicated only by lymphocyte infiltration of the epithelium.

Nevertheless, the finding of a flattened mucosa by way of the biopsy, followed by a marked improvement in symptoms and healing of the intestine upon initiation of a wheat, rye, and barley free diet are a pretty good indication of celiac disease. Because antibody levels decline and the intestinal mucosa recovers on such a diet, it is best for tests to be carried out before the potential celiac patient initiates the appropriate diet, thereby making testing impossible or difficult without a new challenge. This is especially so because the time for a challenge to take effect may vary considerably from person-to-person and too short a challenge might fail to bring about changes sufficient for diagnosis.

The only plants demonstrated to have proteins that damage the small intestines of people with celiac disease are those from wheat, rye, and barley, (and the man-made wheat-rye cross called triticale). Until recently, oats have been considered harmful on the basis of early studies. Several recent studies of very high quality involving testing approaches that were not available to earlier workers, indicate that oats are not harmful to celiac patients or to those with dermatitis herpetiformis, but these findings have not been accepted by all physicians. There is also a practical problem with oats in that they tend to be grown in rotation with wheat or in nearby fields, the same machinery and storage bins might be used for both. Consequently, oats can be contaminated with small amounts of wheat.

Wheat, rye, and barley are members of the grass family and are quite closely related to one another according to various schemes of plant classification (taxonomy). However, not all members of the grass family have proteins capable of damaging the intestines of celiac patients. Rice and corn, for example, are apparently harmless.

Many other grains have not been subjected to controlled testing or to the same scrutiny as wheat, rye, barley, oats, rice, and corn in relation to celiac disease. If we accept corn and rice as safe, then members of the grass family that are more closely related to these species (on the basis of taxonomy) than to wheat are likely to be safe. Such grasses include sorghum, millet, teff, ragi, and Job's tears, which appear to be reasonably closely related to corn, and wild rice, which is closely related to cultivated rice. In some cases, there are protein structure studies that support of this conclusion, although the studies are not sufficiently complete to provide more than guidance. Scientifically controlled feeding studies with celiac patients would provide a better answer. However, such studies are not likely to be carried out in the foreseeable future because of high costs and the difficulty of obtaining patient participation (such studies would be very likely to involve intestinal biopsy and patients are reluctant to undergo challenge once they are well).

The scientific name for bread wheat is *Triticum aestivum*--the first part of the name defines the genus (*Triticum*) and the second part, the species (*aestivum*). Species falling in the genus *Triticum* are almost certain to be harmful to celiac patients. Grain proteins of these species include the various types characteristic of the gluten proteins found in bread wheats (including the [alpha-gliadins](#)) that cause damage to the small intestine in celiac disease. Some *Triticum* species of current concern include *Triticum spelta* (common names include spelt or spelta), *Triticum polonicum* (common names include Polish wheat, and, recently, Kamut), and *Triticum monococcum* (common names include einkorn and small spelt). I recommend that celiac patients avoid grain from these species.

Rye (*Secale cereale*) and barley (*Hordeum vulgare*) are also toxic in celiac disease even though these two species are less closely related to bread wheat than spelta and Kamut. They belong to different genera, *Secale* and *Hordeum*, respectively, and lack alpha-gliadins, which may be an especially toxic fraction. There have been anecdotal reports suggesting a lack of toxicity in

celiac disease for spelta and Kamut. Controlled tests would be necessary to draw a firm conclusion, but I don't consider anecdotal reports as reliable for the following reasons.

The diagnosis, sometimes self-diagnosis, of celiac disease is occasionally made without benefit of reasonably rigorous medical or clinical tests, especially intestinal biopsy. Individuals who are "diagnosed" in this way without rigorous testing may not actually have celiac disease. Claims that particular foods cause this latter group no problems in relation to their celiac disease could cause confusion.

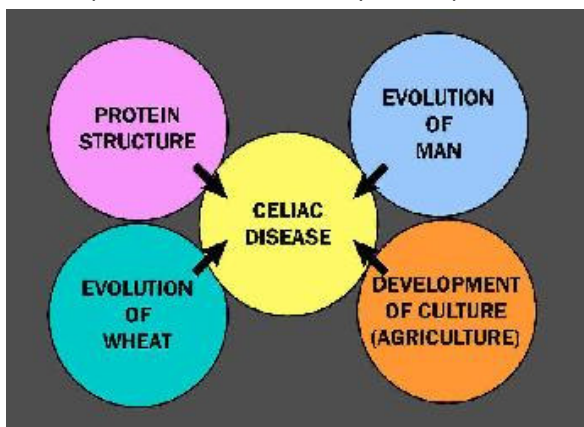
Furthermore, celiac patients who report no problems in the short run with spelta or Kamut will very likely relapse later. There is now adequate evidence that when celiac patients on a "gluten-free" diet (that is, a diet free of any proteins or peptides from wheat, rye, barley, and oats) have wheat reintroduced to their diets, times-to-relapse vary enormously among individuals, ranging from hours to months, or even years. And this is for wheat, presumably the most toxic of all cereal grains to celiac patients.

Additionally, the relapse may not be accompanied by obvious symptoms, but could be recognized only by physicians through observation of characteristic changes in the small intestinal tissues obtained by biopsy. The reasons for the enormous variability of response times are not known. It may be speculated that they have something to do with the degree of recovery of the lining of the small intestine on a gluten-free diet, the degree of stress that the patient had been experiencing (including infections), and individual genetic differences.

As I have indicated, all known grain species that cause problems for celiac patients are members of the grass family. In [plant taxonomy](#), the grass family belongs to the Plant Kingdom Subclass known as monocotyledonous plants (monocots). The only other grouping at the Subclass level is that of dicotyledonous plants (dicots). Some other species about which celiac patients have questions actually are dicots, which places them in very distant relationship to the grass family. Such species include buckwheat, amaranth, quinoa, and rape. The seed of the last plant listed, rape, is not eaten, but an oil is pressed from the seeds that is becoming commonly used in cooking. This oil is being marketed as canola oil.

Because of their very distant relationship to the grass family and to wheat, it is highly unlikely that dicots will contain the same type of protein sequence found in wheat proteins that causes problems for celiac patients. Of course, some quirk of evolution could have given rise in these dicot plants to proteins with the harmful amino acid sequence found in wheat proteins. But if such concerns were carried to a logical conclusion, celiac patients would have to exclude all plant foods from their diets.

It may be in order to caution celiac patients that they may have undesirable reactions to any of these foods--reactions that are not related to celiac disease. Allergic reactions may occur to almost any protein, but there is a great deal of individual variation in allergic reactions, and there are possibly non-allergic food reactions, such as to the sulfites used to preserve certain foods, which further complicates the situation. Also, buckwheat, for example, has been claimed to contain a photosensitizing agent that will cause some people who have just eaten it to develop a skin rash when they are exposed to sunlight. Such reactions, apparently rare, should



be looked for, but for most people, buckwheat eaten in moderation apparently does not cause a problem. (Buckwheat is sometimes found in mixture with wheat, which of course would cause a problem for celiac patients.) It seems no more necessary for all people with celiac disease to exclude buckwheat from their diets because some celiac patients react to it than it would be for all celiac patients to exclude milk from their diets because some celiac patients have a problem with digestion of milk sugar (lactose) or are allergic to milk proteins, such as lactalbumin. Buckwheat, quinoa, and amaranth have been reported to have

relatively high levels of oxalic acid, almost as much as in spinach, and may not be suitable for very young children because the oxalic acid may cause gastrointestinal problems.

Some celiac patients may exhibit allergic reactions to gluten proteins or non-gluten proteins of wheat (and rye and barley), the alpha-amylase inhibitors being an example of the non-gluten proteins that can cause allergic reactions. Related inhibitor proteins can be found in rice as well. Alpha-amylase inhibitors might also interfere with starch digestion, causing symptoms similar to lactose intolerance in people with a weakened digestive capability. Celiac disease is thought to involve delayed immunoreaction and patients would not generally be expected to have an immediate and violent reaction to eating wheat whereas allergic reactions of the immediate hypersensitivity type might be both immediate and violent. It is also possible that both immediate hypersensitivity and delayed reactions might be present in the same person. There is a considerable potential then for confusion between allergy and celiac disease. It may be difficult to distinguish immediate hypersensitivity reactions or allergies from celiac disease as traditionally defined, but more research on this problem is needed.

In conclusion, scientific knowledge of celiac disease, including knowledge of the proteins that cause the problem, and the grains that contain these proteins, is in a continuing [state of development](#). There is much that remains to be done. Nevertheless, steady progress has been made over the years. As far as I know, the following statements regarding various grains are a valid discrimination of the state of our knowledge:

- **Spelt or Spelta and Kamut are wheats.** They have proteins toxic to celiac patients and should be avoided just as bread wheat, durum wheat, rye, barley, and triticale should be avoided.
- **Rice and corn (maize) are not toxic to celiac patients.**
- **Certain cereal grains, such as various millets, sorghum, teff, ragi, and Job's tears are close enough in their genetic relationship to corn to make it likely that these grains are safe for celiac patients to eat.** American wild rice is sufficiently closely related to normal rice that it is likely also to be safe. Significant scientific studies with celiac patients have not been carried out, however, for these grains.
- **There is no reason for celiac patients to avoid plant foods that are very distantly related to wheat.** These include buckwheat, quinoa, amaranth, and rapeseed oil (canola). Some celiac patients might suffer allergies or other adverse reactions to these grains or foodstuffs made from them, but there is currently no scientific basis for saying that these allergies or adverse reactions have anything to do with celiac disease. A celiac patient may be lactose intolerant or have an allergy to milk proteins, but that does not mean that all celiac patients will have an adverse reaction to milk.

related web sites:

- <http://www.celiac.com/>
- <http://www.panix.com/~donwiss/>
- <http://www.dietitian.com/gluten.html>
- <http://www.gretmar.com/webdoctor/celiac.html>
- <http://cpmcnet.columbia.edu/dept/gi/celiac.html>
- <http://www.vtmednet.org/~naspagn/celiac.html>
- <http://www.nutrimed.com/SPRUE.HTM>

A list of my publications with pertinence to celiac disease follows. Cross-references to the literature for most of the points discussed above can be found in these publications.

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