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Nutritional Aspects of Common Food Sensitivities: Celiac Disease and Lactose Intolerance

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Food sensitivities can include reactions mediated by a spectrum of etiological mechanisms, including food allergy (an immunologically mediated response), food intolerance (a non-immunologically mediated reaction), and genetically-determined autoimmune processes such as celiac disease (gluten-sensitive enteropathy). Although the etiological mechanisms are significantly different, in each case of adverse response to food, the same management strategies are required: accurate identification of the food(s) responsible, avoidance of the offending food(s), and substitution of the eliminated nutrients. A diet supplying complete balanced nutrition is necessary for good health – and critical for babies and children at important stages in their growth and development. It is therefore essential that anyone dealing with restricted diets, either as patient or clinician, should be fully informed about the nutrient composition of foods. A knowledge of the macronutrients (protein, carbohydrate, fat), and the most important micronutrients (vitamins and minerals) in a food allows substitution with nutritionally equivalent sources when specific foods need to be eliminated from the diet.

In this article we take a look at celiac disease and lactose intolerance, which often occur concomitantly; the latter can result from untreated celiac disease as the villous damage associated with gluten-sensitive enteropathy reduces the lactase-producing capacity of the brush-border cells.

CELIAC DISEASE

Celiac disease (gluten-sensitive enteropathy) is a genetically determined condition in which grain proteins – specifically, certain glutens - cause an autoimmune response that damages the lining of the small intestine, causing blunting of the villi and malabsorption of nutrients. The glutens associated with celiac disease, are the prolamins (storage proteins) in wheat (gliadin), rye (secalin) and barley (hordein)[1]. A strict, lifelong gluten-free diet which eliminates all forms of wheat, barley and rye and their derivatives[2] is currently the only treatment for celiac disease. Historically, oats were excluded from the diet because it was thought that avenin (the storage protein found in oats) was also toxic to gluten-intolerant individuals. However, recent research has demonstrated that when consumed in moderation, oats are well-tolerated by most children and adults with celiac disease and do not contribute to abdominal symptoms, serological or mucosal relapse, nor prevent small bowel healing[3].

NUTRIENT INADEQUACIES AND MANAGEMENT

Wheat and wheat products are a significant source of thiamin, riboflavin, niacin, iron, selenium, chromium and in smaller amounts, magnesium, folate, phosphorus and molybdenum[5]. These vitamins and minerals are present in whole-grain cereals. When the grain is refined, as in making flours, some of these micronutrients are lost. Government regulations of many countries, including the USA[4] and Canada[5] require that these micronutrients are added to flours after manufacture, so most wheat-based products in the marketplace are a source of these nutrients. Such products are usually designated "enriched".

Foods that can replace gluten-containing grains in the gluten-free diet include oats (if allowed), rice, corn, buckwheat, amaranth, quinoa, and millet some of which may be fortified with micronutrients similar to those in wheat products.

Flours that are suitable as replacements for wheat flour include flours made from the above grains, and in addition, starches from root vegetables such as potato, tapioca, arrowroot, and teff.

Dietary surveys have found that adults with celiac disease on gluten-free diets often consume less than the recommended amounts of B vitamins (folate, thiamin, niacin, riboflavin), iron, calcium and fiber[6,7,8]. Because many gluten-free products are not enriched or fortified and frequently made with white rice or other highly refined flours, these foods are often poor sources of these nutrients.

Alternative sources of the deficient nutrients include meats (especially organ meat such as liver), nutritional yeast (B vitamins), vegetables, legumes, bean flours, whole gluten-free grains (such as brown rice, millet, amaranth and quinoa), flax, enriched corn flour and corn meal, enriched rice, enriched gluten-free pastas, broccoli, asparagus, oranges, peanuts, tree nuts, and seeds (such as flax, sunflower and sesame).

Additional sources of the nutrients can be provided by including gluten-free foods specifically manufactured for the gluten-free diet[9,10].

LACTOSE INTOLERANCE

Lactose intolerance is a result of a reduced capacity to metabolize lactose, the principal sugar in milk of all mammals. The condition (hypolactasia) is due to a decline in the level of the enzyme responsible for metabolism of lactose. In order to be absorbed, lactose is hydrolyzed in the intestine by a beta-galactosidase, lactase-phloritzin hydrolase, generally called lactase. The hydrolysis products, glucose and galactose, pass through the digestive mucosa into circulation by means of an energy-requiring active transport system. Lactase, whose sole function is the hydrolysis of lactose, is produced in the jejunum.

The symptoms of lactose intolerance are typically localized in the digestive tract and include abdominal discomfort, bloating, excessive flatulence and, frequently, diarrhea, as a consequence of undigested lactose in the bowel. Undigested lactose passing into the large intestine provides a substrate for microbial fermentation, and also increases the osmotic pressure within the bowel lumen, resulting in excess fluid and gases.

Hypolactasia has a number of causes, leading to either temporary or permanent lactose intolerance.

Congenital Hypolactasia

Congenital hypolactasia, although extremely rare, renders an infant incapable of metabolizing lactose from birth[11]. The most important sign of the condition is intractable diarrhea as soon as the baby consumes human milk or lactose-containing formula. Because lactose, as a constituent of human milk, is the most important source of energy during the first year of a human's life, providing almost half the total energy requirement of infants, deficiency in lactase requires careful feeding with a lactose-free source of milk, either maternal milk treated with lactase enzyme before feeding, or a lactose-free infant formula.

Secondary Hypolactasia

More frequently, a temporary state of lactose intolerance in infancy and childhood results from damage to the brush-border cells of the jejunum, as a result of digestive tract infections, such as rotovirus[12]. In most cases of childhood hypolactasia, lactase production resumes soon after the infection resolves.

Primary Hypolactasia

Permanent loss of lactase activity is common in adult humans: an estimated 70 - 95% of adults experience some degree of lactose intolerance, usually starting in late childhood. The condition seems to be racially determined, with some races being more prone to the condition, with earlier onset and a greater degree of lactase deficiency than others[13]. From a world view, lactose intolerance can be regarded as "normal" for adult humans [14,15].

DISTINGUISHING BETWEEN MILK ALLERGY AND LACTOSE INTOLERANCE

Milk allergy is a response of the immune system; lactose intolerance is due to an error in metabolism. The etiology of the two conditions is quite distinct. It is sometimes difficult to distinguish milk allergy from lactose intolerance on the basis of clinical symptoms alone, because some of the symptoms such as abdominal pain, diarrhea, nausea, vomiting, gas, and bloating, are common to both conditions. However, milk allergy usually results in symptoms in other organs, such as the upper respiratory tract (for example, a stuffy, runny nose), itching, fluid drainage from the ears, or skin reactions (such as eczema or hives), which lactose intolerance does not[16].

Because milk is the only source of lactose in the normal diet, eliminating milk from the diet will cure both conditions, but will not distinguish which was the cause. It is important to determine which condition is causing the problem, because milk and milk products are a significant source of nutrients (especially protein, calcium, and when fortified, vitamins A and D), which are important for the nutrition of infants and young children, and should not be eliminated unless it is absolutely necessary to do so.

NUTRIENT INADEQUACIES AND MANAGEMENT

Many lactose maldigesters tolerate small amounts of lactose without remarkable discomfort. However, most lactose-intolerant individuals need to limit their consumption of lactose, maintaining their daily intake to below the level at which their symptoms develop. This is usually between 3 grams (severely lactose intolerant) to 12 grams (mildly lactase deficient). Table 2 provides a list of the amount of lactose in commonly consumed milk products. Of course, many lactose intolerant individuals choose to avoid lactose altogether.

Pharmaceutical preparations of fungal or yeast-derived beta-galactosidase have been developed for the treatment of lactose maldigestion. These preparations in the form of tablets or liquid, increase lactose digestion and alleviate symptoms to varying degrees, but different preparations seem to vary in their effectiveness and they do not help all subjects[17]. Lactase is also available as a liquid to be added to milk and milk products before consumption.

Commercially produced lactose-free or lactose-reduced milks are made by hydrolysis of the lactose in regular milk by lactase preparations. The resulting product (Lactaid™; Lacteeze™) is marketed as 99% lactose-free. Ice cream and other products made from lactose-reduced milk are also commercially available. These products provide all of the nutrients in milk, minus lactose, so no alternative sources of nutrients need to be provided when lactose-reduced milk is included in the diet.

The recommended feeding of the temporary lactose intolerant breast-fed baby is to continue breast-feeding. The condition will resolve spontaneously in the majority of cases. For the formula fed infant, lactose-free infant formulas, containing complete cow's milk proteins, are available from a variety of manufacturers.

SUMMARY AND CONCLUSIONS

Avoidance of the offending food is the only way to manage adverse reactions to foods (food sensitivities), regardless of the etiology of the condition. Strict elimination of foods because of food sensitivities can interfere with good nutrition. It is essential that the diagnosis be proven, and the culprit food(s) accurately identified in order to avoid unnecessary food restrictions. The food-sensitive individual must understand where their offending foods and intolerance triggers are found, and how to find appropriate substitutes for the eliminated foods and corresponding nutrients. A nutrition assessment is an essential part of clinical management. Identifying nutrition-related problems early can prevent long-term health consequences[19].

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Table 1. Alternative sources of nutrients in gluten-containing grains

Nutrient	Alternative Grain Sources	Other Sources of Nutrients†
Carbohydrate Fiber *Thiamin *Riboflavin *Niacin *Iron Selenium Chromium Smaller amounts: *Folate Phosphorus Magnesium Molybdenum	**Whole grains:** Oats (if allowed) Rice Corn Buckwheat Amaranth Quinoa Millet ****Flours** from above grains ****Baked products** from above grains and flours ****Breakfast cereals** made from above grains ****Pasta** made from above grains	**B vitamins and Iron:** Organ meats (such as liver) **Carbohydrate and Fiber** Legumes Nuts Seeds Flours made from legumes Pastas made from legumes Fruits and Vegetables **Folate:** Fruits and vegetables especially: Broccoli Asparagus Oranges

* Added to enriched flours and grain products during manufacture

** When added to specialty Gluten-free products during manufacture

†For a more comprehensive list of alternative sources of micronutrients, please see Reference 5

Table 2. Levels of lactose in normal serving sizes of common foods and beverages[18]

Product	Serving Size	Lactose (Grams)
Sweetened condensed milk	125 mL (½ cup)	15
Evaporated milk	125 mL (½ cup)	12
Milk (homogenized, fate-reduced and skim)	250 mL (1 cup)	11
Buttermilk	250 mL (1 cup)	10
Ice milk	125 mL (½ cup)	9
Ice cream	125 mL (½ cup)	6
Half-and-half light cream	125 mL (½ cup)	5
Yogurt, low fat	250 mL (1 cup)	5
Sour cream	125 mL (½ cup)	4
Cottage cheese, creamed	125 mL (½ cup)	3
Whipping cream	125 mL (½ cup)	3
Cottage cheese, uncreamed	125 mL (½ cup)	2
Sherbet	125 mL (½ cup)	2
Most hard cheeses such as Cheddar, Swiss, Blue, Parmesan, etc.	30 g (1 oz)	≤1
Cream cheese (e.g. Philadelphia™)	30 g (1 oz)	≤1
Lactaid™ milk	125 mL (½ cup)	0.025
Butter	5 mL (1 tsp)	trace

The Whitehall-Robins Report is a Wyeth Consumer Healthcare Inc. publication that focuses on current issues on the role of vitamins and minerals in health promotion and disease prevention. Complimentary copies are distributed to Canadian health care professionals active or with a special interest in nutrition. Each issue is written and/or reviewed by independent health care professionals with expertise in the chosen topic.

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