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Advanced Glycation End Products

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Studies show these harmful compounds may lead to insulin resistance and type 2 diabetes.

It's well-known that overeating and obesity can lead to insulin resistance, triggered by chronically elevated oxidative stress and chronic inflammation. Recent evidence has found that excessive consumption of advanced glycation end products (AGEs), harmful compounds that stem from cooking foods at high temperatures and accumulate in the body as people age, are a major cause of this inflammation that can increase the risk of insulin resistance and type 2 diabetes.

Dietary interventions that reduce the consumption of foods high in AGEs, which are common in the standard Western diet, can be effective in helping prevent these metabolic disorders.

Understanding AGEs

AGEs naturally form inside the body when proteins or fats combine with sugars (glycation). This affects the normal function of cells, making them more susceptible to damage and premature aging. AGEs are particularly high in animal-derived foods that are high in fat and protein, such as meats (especially red meats), which are prone to AGE formation through cooking. Sugary foods and highly processed and prepackaged products also are high in AGEs. Cooking methods that use high temperatures to brown or char foods, such as grilling, roasting, and broiling, have the largest impact on the amount of AGEs consumed.

The body naturally rids itself of harmful AGE compounds, but it doesn't eliminate them effectively when too many are ingested through food. All of the body's cells are affected by the accumulation of AGEs, which not only have been linked to aging but also the development or worsening of many chronic illnesses, such as cardiovascular, liver, and Alzheimer's diseases.

Dietary Intervention

To reduce AGE consumption, eating foods that contain low AGE levels is key to decreasing the risk of insulin resistance and type 2 diabetes. "We believe strongly that dietary restriction of AGEs are of tremendous importance," says Jaime Uribarri, MD, a professor of medicine and nephrology at Mount Sinai School of Medicine in New York City, who's conducted extensive research on AGEs and their effects on diabetes patients.

According to one study, published in the July 2011 issue of ***Diabetes Care***, in which Uribarri was the lead author, AGE consumption may contribute to insulin resistance in type 2 diabetes, and restricting AGE foods may help preserve the body's natural defenses against insulin resistance by preventing the development of oxidative stress. In the study, two groups of diabetes patients following the recommended standard of care for diabetes were randomized to either a high- or low-AGE diet. The results of the group who ate a low AGE diet "went far and beyond [those receiving] standard care. The AGE-restricted diet improved insulin resistance in those individuals. This is very impressive to us," Uribarri says.

Another study coauthored by Uribarri, published in the January issue of ***Current Diabetes Reports***, showed that because AGEs are associated with oxidative stress, they're of particular concern to patients with diabetes and prediabetes. The researchers found that subjects who consumed a meal with a high AGE content had an increased circulation of AGEs in the body, and that lowering dietary AGE intake could improve hyperinsulinemia by about 40% in type 2 diabetes patients. Excessive intake of AGEs as a potential cause of diabetes is "an area of major clinical relevance," the study concluded.

In research that's under way and due to conclude in June, Uribarri is following a group of prediabetes patients with classic diabetes indicators, or metabolic risk factors, such as large waist circumference and hypertension, who are following a low-AGE diet for one year. He's confident the results will support his previous findings that a low-AGE diet can play a role in preventing diabetes.

Modifying Cooking Methods

The most effective way to reduce intake of foods high in AGEs is to modify cooking methods. In a study published in the June 2010 issue of the *Journal of the American Dietetic Association*, Uribarri and colleagues developed a guide to AGE dietary reduction. The researchers found a link between heat-processed foods and AGEs. They compared different types of cooking methods and found that dry heat promoted AGE formation by more than 10- to 100-fold above uncooked foods in all food categories. Meats high in protein and fat were likely to form AGEs during cooking, while carbohydrate-rich foods such as fruits, vegetables, and whole grains maintained low AGE levels after cooking. Foods cooked with moist heat, shorter cooking times and lower temperatures, and acidic ingredients such as vinegar or lemon juice produced the least amount of AGEs.

A Danish study published in the January issue of *Diabetes Care* showed that overweight women who ate foods cooked at high temperatures had much higher biological markers of insulin resistance compared with those who ate foods prepared by boiling or steaming.

Pat Baird, MA, RD, FADA, a member of the advisory board of the AGE Foundation, an organization committed to educating the public about the harmful effects of AGEs, is optimistic about sharing the benefits of a low-AGE diet. "We produce AGEs in our body, and we're also ingesting them. The good news is we can adjust it," she says, adding that preparing foods in a slow cooker is another good option.

Insider Tips

Despite these recommendations, Baird knows that people will continue to grill their food, so she encourages them to do so less frequently. When they do grill, however, she suggests they use an acid-based marinade that contains lemon or other citrus fruit juices, or vinegar. Not only does the acidity reduce AGE levels, "it enhances the flavor of food and enhances the flavor of the spices," she says. "The indication is color."

Whether on the grill, in a skillet, or in the oven, browning or charring foods is an indication that AGEs are present. Baird also suggests cooking foods with medium heat for an extra minute or two instead of using high heat.

Because it can be a challenge for people to eat fewer convenience foods, such as packaged snacks and ready-to-eat meals, Baird says using slow cookers can help, especially in families that often are short on time. But the benefits go beyond time-saving convenience. According to Baird, less oil is needed in slow cookers, more nutrients are retained compared with many other cooking methods, and recipes tend to include more vegetables.

In fact, eating more vegetables and fruits is another way to reduce AGE consumption. Baird stresses the importance of dietary phytonutrients, which are found in the pigments of various colorful fruits and vegetables. One type of phytonutrient in particular, called iridoids, which are found in deeply colored blueberries, cranberries, and noni fruit, can lower AGEs in the body, she says.

Counseling Clients

Counseling patients about AGEs is straightforward, Baird says. Dietitians already recommend patients eat less sugar and fewer processed foods, which is what they should suggest to clients who need to lower their AGE intake.

In addition, people who are sleep deprived have higher circulating AGEs, Baird says. Sleep is the time when the body does most of its tissue growth and repair, making it better able to defend itself against AGEs. Sleep, daily activity, and stress reduction play important roles, along with diet, to reduce AGEs.

While most dietitians understand this, Baird says, the new research may not be so familiar. The AGE Foundation website (<http://agefoundation.com>) is an ideal source to bring dietitians up-to-date on the most current research, complete with background information, resources, and FAQs. There's even information on AGE scanners that use LED light to penetrate the skin and measure AGE levels. According to Baird, this technology, which currently is being tested in clinical trials, may one day be a useful noninvasive tool for dietitians to use.

Uribarri and Baird look forward to dietitians becoming more familiar with the topic of AGEs. "They should be the first to embark on this chain," Uribarri says. Patients with prediabetes and diabetes may benefit from the healthful lifestyle of a low AGE diet.

— Lori Zanteson is a food, nutrition, and health writer based in southern California.

Tips for Lowering AGE Consumption

Foods High in AGEs

- Sugary items such as candy, cookies, cakes, soda, and pastries
- Processed foods, including packaged meats and cheese
- High-fat (especially red) meats
- Fats, including butter, margarine, and oil
- Fried foods

Foods Low in AGEs

- Fruits and vegetables
- Seafood
- Whole grains
- Low-fat breads
- Pasta
- Vegetarian burgers

Cooking Methods

- Use a slow cooker
- Cook foods in water through boiling, steaming, or poaching
- Marinate foods in acidic or citrus-based sauces

Healthful Lifestyle Changes

- Get the recommended seven to nine hours of sleep per night
- Exercise 150 minutes per week
- Treat preexisting conditions such as obesity and high blood pressure

— Source: AGE Foundation