

Alterations in Glycemic Index and Resistant Starch Content Based on Food Variety and Cooking Method: Implications for Blood Glucose Management

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Glycemic index (GI) is a measure of how much a carbohydrate-containing food will likely raise blood glucose, with low GI foods as the ideal for maintaining blood glucose control.¹ As is known in individuals with diabetes, blood glucose control is essential and learning to maintain by way of proper food choices can be a valuable tool. Although foods with differing GI will not necessarily differ in carbohydrate amount, knowing the GI of particular foods can be helpful for individuals motivated to learn advanced glucose control.

The GI of a food item can be affected by a number of factors, including ripeness, processing, cooking method, and variety. Examples provided by the American Diabetes Association¹ include:

- Ripe bananas have higher GI than unripe
- Apple juice has a higher GI than a whole apple
- Mashed potato has a higher GI than baked potato
- Instant oatmeal has a higher GI than steel-cut oats
- Soft-cooked pasta has a higher GI than al dente
- Long-grain white rice has a lower GI than brown rice, but short-grain white rice has a higher GI than brown rice

Low GI foods (55 or less)

100% whole grains, oatmeal (rolled or steel-cut), oat bran, pasta, converted rice, barley and bulgur, sweet potato, corn, yam, lima/butter beans, peas, legumes, lentils, and most fruits, non-starchy vegetables, and carrots.

Medium GI foods (56-69)

Whole wheat, rye, and pita bread; quick oats; brown, wild or basmati rice; and couscous.

High GI foods (70 or more)

White bread; prepared cereals, instant oatmeal; short-grain white rice, rice pasta, and boxed mac and cheese; white potato; pumpkin; refined grains in pretzels, rice cakes, and crackers; melon and pineapple.

(ADA; 2014)

Resistant starch is a naturally occurring starch found in potato, legumes, corn, rice, grains, and other starchy food items² – particularly those food items with a low glycemic index (GI). Although a starch by name, it behaves more like a fiber, resisting digestion until reaching the large intestine where it is fermented by colonic bacteria to produce short chain fatty acids (SCFAs) important for health.³ As a fiber, resistant starch has been shown to lower the glycemic response and raise insulin sensitivity, as shown in various studies in healthy individuals, those with diabetes, and in animals both with and without diabetes.³

Some sources of isolated raw resistant starch include potato starch, plantain flour, green banana flour, cassava/tapioca starch, and mung bean starch. Green banana flour has been shown to have a low glycemic index and may subsequently reduce fasting blood glucose.⁴ Additionally, studies assessing specialty high-amylose white rice and whole grain high-amylose maize flour found a lowering effect on postprandial blood glucose in healthy subjects.^{5,6} However, these specialty pasta, rice, and starch isolate varieties are not

Resistant starch exists in four types:

- *RS Type 1* – bound by indigestible plant cell walls; found in beans, grains, and seeds.
- *RS Type 2* – indigestible raw due to high amylose content, though accessible upon heating; found in potatoes, bananas, and plantains.
- *RS Type 3* – retrograde starch formed through cooking and cooling, which changes the structure to act more like a fiber – resistant to digestion; found in cooked and cooled potatoes, grains, and beans.
- *RS Type 4* – chemically modified
- *RS Type 5* – amylo-lipid complexes

(Chiu YT & Stewart ML; 2013)

necessarily easy for the average consumer to obtain, either for availability or economic reasons.

In a 2013 study assessing the impact of rice variety and cooking methods on resistant starch content – and ensuing postprandial glucose response – refrigerating and reheating of long, short, and medium grain rice initially cooked in a rice cooker resulted in increased resistant starch content.² Interestingly, pressure-cooking significantly reduced the resistant starch content in jasmine rice and short grain rice, and the resistant starch content remained low even after refrigeration.² When fed to healthy participants in the clinical trial to follow, no significant differences in postprandial blood glucose were seen between the rice varieties with lowest (0.20 g RS/100 g) or highest (2.55 g RD/100 g) resistant starch content.² These results may not be generalizable to the diabetes population though, as blood glucose may be more susceptible to small alterations in resistant starch content more so than in a healthy population with stable blood glucose.

Research is minimal regarding the efficacy of cooking methods in transforming starch, specifically the claim that cooking, cooling, and reheating white pasta may transform starch into a retrograde form that behaves more like a fiber. Dr. Denise Patterson, a researcher out of Surrey, England, has been featured in multiple news outlets, including BBC News, for her findings concerning this claim. In her study, she assessed changes in the starch structure when cooking, cooling, and reheating pasta, but also assessed the *effect* of the retrograde starch on blood sugar control in a human population.^{7,8} Dr. Patterson found that eating refrigerated pasta resulted in a much smaller rise in postprandial blood glucose than eating fresh, warm pasta.⁸ Furthermore, in trials to follow, reheating the refrigerated pasta resulted in an even more subdued rise in postprandial blood glucose, suggesting that reheating continues to alter the resistant starch content.⁷ Although unpublished, her findings and others could have beneficial implications for many parents who struggle to get their child with diabetes to veer from high glycemic index, white pastas, rice, and potatoes.

Takeaways:

- Resistant starch is naturally more prevalent in low GI foods, such as 100% whole grains, sweet potato, long-grain rice, legumes, and seeds. Individuals with diabetes should focus on incorporating low GI, resistant starch foods into their diet daily.
- Although not definitive, cooking, refrigerating, and reheating may maintain or raise the resistant starch content in some foods such as pasta, rice, and potatoes, and have a subsequent beneficial effect on blood glucose.
- Overcooking should be avoided, as an increasingly broken down food will have lower resistant starch content and a higher glycemic index.
- For individuals with diabetes who are resistant to swapping white rice for long grain brown rice or white pasta for 100% whole wheat, the cook-refrigerate (-reheat) method may be a beneficial tool to educate on.

References:

¹ Glycemic Index and Diabetes. American Diabetes Association Web site. <http://www.diabetes.org/food-and-fitness/food/what-can-i-eat/understanding-carbohydrates/glycemic-index-and-diabetes.html>. Edited 14 May 2014. Accessed 20 Oct 2015.

² Chiu YT, Stewart ML. Effect of variety and cooking method on resistant starch content of white rice and subsequent postprandial glucose response and appetite in humans. *Asia Pac J Clin Nutr*. 2013;22(3):372-9.

³ Zhang L, Li HT, Shen L, Fang QC, Qian LL, Jia WP. Effect of Dietary Resistant Starch on Prevention and Treatment of Obesity-related Diseases and Its Possible Mechanisms. *Biomed Environ Sci*. 2015 Apr;28(4):291-7.

⁴ Tavares da Silva S, Araújo Dos Santos C, Marvila Gironcoli Y, et al. Women with metabolic syndrome improve anthropometric and biochemical parameters with green banana flour consumption. *Nutr Hosp*. 2014 May 1;29(5):1070-80.

⁵ Luhovyy BL, Mollard RC, Yurchenko S, et al. The effects of whole grain high-amylose maize flour as a source of resistant starch on blood glucose, satiety, and food intake in young men. *J Food Sci*. 2014 Dec;79(12):H2550-6.

⁶ Zenel AM, Stewart ML. High Amylose White Rice Reduces Post-Prandial Glycemic Response but Not Appetite in Humans. *Nutrients*. 2015 Jul 2;7(7):5362-74.

⁷ Is reheated pasta less fatteneing? BBC News Web site. <http://www.bbc.com/news/magazine-29629761>. Published 16 Oct 2014. Accessed 20 Oct 2015.

⁸ A healthy meal: Cooking and cooling pasta changes starch quality to cut calories, fat. Medical Daily Web site. <http://www.medicaldaily.com/healthy-meal-cooking-and-cooling-pasta-changes-starch-quality-cut-calories-fat-307300> Published 17 Oct 2014. Accessed 20 Oct 2015.