



Prediabetes Potential

Citrus flavonoids can help improve blood glucose levels, maintain a healthy inflammatory response, and improve antioxidant activity, one guest author writes.

BY ROB BREWSTER



One in three U.S. adults is prediabetic¹, and with no apparent signs or symptoms, many of those affected don't even realize it until it is too late. So, what is prediabetes? Prediabetes is a group of health conditions that indicate a decline in the body's ability to maintain glucose levels within the parameters necessary for healthy function. Prediabetes is a precursor to type 2 diabetes. The American Diabetes Association (ADA) projects that 70% of prediabetic adults will eventually progress to type 2 diabetes², which leads to complications in vital organs such as kidneys, eyes, and lower limbs, and a higher incidence of cardiovascular disease.

Prediabetes occurs as sedentary lifestyles, obesity, abdominal fat, and unhealthy eating patterns negatively affect the body's ability to metabolize carbohydrates. This results in fasting blood sugar levels that are higher than normal, yet still below the diabetic range. But elevated blood sugar levels isn't the only factor that needs to be addressed. As blood sugar levels increase, they begin a cycle of increased oxidative stress and inflammation³, making it more difficult to drop back down to a healthy range.

Addressing Prediabetes with Citrus

Healthcare costs from diabetes, both direct and indirect, continue to increase¹, and there is an urgent need for safe, effective, and affordable approaches for diabetes prevention. The ADA states that a prediabetic condition is reversible through lifestyle changes that include a healthy diet and regular exercise. But in order to efficaciously address prediabetes, that cyclical interaction of blood glucose levels with insulin sensitivity, inflammation levels, and oxidative stress must also be addressed. In addition to modifications to current lifestyles, affected persons can look to supplementation as a viable means to better health.

There has been much research into the effectiveness of flavonoids for improved health outcomes, including antioxidant support and anti-inflammatory activity. A major source of flavonoids comes from fruits and plants and were first discovered in citrus.⁴ Individual studies on citrus flavonoids have made it clear that addressing the many physiological systems—which interact to improve insulin resistance and glucose uptake—helps to manage prediabetes and its interrelated health concerns.⁵

(Disclosure: The author's company, Ingredients by Nature, partially funded this study, which was performed on the company's Eriomin ingredient.)

The Insulin-Resistance Dilemma

The body relies on insulin to help regulate the entry of glucose into cells and organs. However, as the body enters a prediabetic condition, the hormone GLP-1, which increases insulin secretion by the pancreas and improves glucose uptake, begins to degrade from the enzyme DPP-4, which inhibits insulin secretion. As a result, the body starts to build up a resistance to insulin and tries to compensate by delivering increased amounts of insulin. Over time, the functionality of insulin-producing beta cells decreases, and blood glucose levels rise.

As seen when studying the flavonoid naringin, lemon flavonoids have the ability to inhibit the DPP-4 enzyme. This helps to prevent the hydrolysis of GLP-1 and thereby improves insulin secretion and glucose uptake.⁶ When blending multiple lemon flavonoids, such as eriocitrin, hesperidin, and naringin, one study showed an improvement in blood glucose levels as a result of reduced insulin resistance and increased GLP-1 levels.⁵

Cycling into Inflammatory Issues

Prediabetes is associated with low-grade systemic inflammation, indicated by the increase of pro-inflammatory cytokines, such as interleukin 6 (IL-6) and C-reactive protein (CRP), which are strong indicators of type 2 diabetes risk.⁷ As the pro-inflammatory cytokines increase, they are eventually released into the bloodstream and reach the liver and pancreas, resulting in dysfunctional beta-pancreatic cells. The body will also further develop an insulin resistance, which then leads to a chronic cycle of cytokine production and further inflammation, contributing to long-term micro- and macrovascular complications.⁸

Addressing inflammation is a necessary effort towards the normalization of glycemia and improvement of insulin resistance to prevent further development. Lemon flavonoids have demonstrated that short-term intervention can significantly reduce the secretion of IL-6 and CRP, along with other pro-inflammatory cytokines, by activating PPAR- γ expression to inhibit those cytokines and NF- κ B, a protein complex that controls cytokine production.^{9,10} Hesperidin, eriocitrin, and naringin have specifically shown a successful increase of adiponectin for decreased insulin resistance in addition to their ability to support cytokine reduction.⁵

Improving Antioxidant Defense

As blood glucose levels elevate and inflammation progresses beyond a normal range, reactive oxygen species (ROS) production begins to accelerate, creating unhealthy levels of oxidative stress. The growth of free radicals begins to outpace the rate of antioxidant production, such as glutathione (GSH). That lack of a sufficient antioxidant defense mechanism to neutralize the ROS allows the excessive levels of ROS to cause damage to proteins, carbohydrates, and lipids. Combined with heightened inflammation from CRP, the damage from oxidative stress cycles back to the root issue to cause further glucose intolerance and insulin resistance.¹¹

It has long been known that citrus contains powerful antioxidant properties. As such, lemon flavonoids can provide both short- and long-term protection against oxidative stress by helping to prevent the formation

of and neutralize ROS. Studies of the lemon flavonoids naringenin, hesperidin, and eriocitrin have attributed them to reduced ROS as they enhance the body's antioxidant defense mechanisms. These defense mechanisms are supported to be able to increase the levels of reduced GSH, vitamin C, and vitamin E in addition to suppressing excessive ROS production and thereby preventing oxidative damage.^{5,12,13}

Make Lemon-Aid

Ideally, the first intervention is to start taking steps towards an improved diet and more regular exercise. Even small changes can largely impact prediabetes management. But, when life gives lemons, supplementing with clinically validated "lemon-aid" can help provide the body an additional boost towards supporting normalized blood glucose levels, a healthy inflammatory response, and improved antioxidant activity. A lemon a day may just keep the doctor away. **N**

Rob Brewster is president of Ingredients by Nature (Montclair, CA). As a third-generation ingredient manufacturer for the natural products industry, Rob Brewster is proud to be part of the health and wellness world. He has followed in his grandfather's and father's footsteps, helping their company Brewster Foods grow since he joined in the 1990s and then developing it into Ingredients by Nature, the world leader of citrus bioflavonoids and extracts. As president of Ingredients by Nature, Rob takes pride in citrus science and continues to invest heavily in citrus flavonoid science for condition-specific applications. Ingredients by Nature recently launched its latest branded lemon flavonoid blend, Eriomin, for prediabetes management. Rob holds degrees in Business Administration and Biology from California State University.

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