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File: ■ Yerba Maté (*Ilex paraguariensis*, Aquifoliaceae)
■ Obesity

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RE: Yerba Maté May Be Helpful against Obesity

Gambero A, Ribeiro ML. The positive effects of yerba maté (*Ilex paraguariensis*) in obesity. *Nutrients*. January 22, 2015;7(2):730-750.

As the prevalence of obesity rises worldwide, researchers continue to seek lifestyle and diet modifications to slow the epidemic. Many are studying natural products as anti-obesity candidates, and both in vitro and in vivo studies report yerba maté (*Ilex paraguariensis*, Aquifoliaceae) leaf's effects on obesity and obesity-related inflammation. The authors summarize and discuss these effects.

Obesity involves social, biological, and cultural factors. Sedentary lifestyle and a high-calorie diet seem most important in its development. It is a major public health concern because weight-related disorders cause considerable mortality, morbidity, and lowered quality of life. Low-grade inflammation in adipose (fatty) tissue, now known to be not only an energy (in the form of fatty acids) storage and release organ but also an active endocrine organ secreting many hormones and signaling compounds, is a precursor of obesity-related disorders, e.g., type 2 diabetes and cardiovascular disease. Compounds originating in adipose tissue alter satiety and appetite control, glucose and lipid metabolism, blood pressure regulation, inflammation, and immune modulation.

Exactly how inflammation develops in adipose tissue is not yet fully understood and involves multifactorial mediators and mechanisms. Changes in macrophage phenotype ratio, free fatty acid concentrations, and hypertrophied adipocytes may all contribute to increased production of pro-inflammatory mediators and lower levels of anti-inflammatory ones. Activated pro-inflammatory pathways in adipose tissue start an inflammatory cascade. Inflammatory mediators in adipose tissue limit the ability of preadipocytes to differentiate, impairing insulin signaling and glucose uptake. Adipogenesis involves several genes, with peroxisome proliferator-activated receptor-γ (PPARγ) being a major regulator, vital for late stages of differentiation. It is suggested that self-regulation of PPARγ and transcription factor CCAAT/enhancer-binding protein (C/EBP)-α is key to adipocyte differentiation. Dietary compounds such as polyphenols and some fatty acids suppress systemic and adipose tissue inflammation and may be of benefit in obesity-related disorders.

Yerba maté, from subtropical South America, is traditionally consumed in four different aqueous extracts ("teas"). *Chimarrão* and *tererê* are each made with dried, crushed green leaves; the first with hot water, the second with cold. *Maté tea*, from roasted

leaves, and *maté cocido*, from green leaves, are brewed with hot water; the latter is often sold commercially as "maté tea." Biological activities attributed to yerba maté are thought to be due to its polyphenol content, including flavonoids (rutin and quercetin) and phenolic acids (caffeic and chlorogenic acids); it also contains caffeine and saponins. Antioxidant activity, protective effects against induced DNA damage, vasodilation, inhibition of glycation and atherosclerosis, better glucose tolerance, better insulin resistance, and anti-inflammatory, anti-cancer, thermogenic, and anti-obesity effects are reported.

A 2001 double-blind, controlled, parallel trial found that a preparation with "YGD" (yerba maté, guaraná [*Paullinia cupana*, Sapindaceae], and damiana [*Turnera diffusa*, Passifloraceae]) significantly delayed gastric emptying, reduced time to satiety, and caused significant weight loss over 45 days in overweight patients. In a randomized, controlled trial (RCT), YGD caused acute reductions in calorie intake and meal duration in healthy women. In a 2009 single-blind RCT in healthy subjects with normo- or dyslipidemia, significant reductions in lipids and improved lipid profiles were seen at 20 and 40 days of yerba maté use.

In vivo studies in high-fat diet models report that yerba maté promotes satiety through mechanisms including inducing and/or enhancing intestinal glucagon-like peptide-1 (GLP-1), modulation of serum leptin levels, and possibly direct central satiety-stimulatory effects. It suppresses body weight gain and visceral fat accumulation and decreases serum lipids, glucose, insulin, pancreatic lipase, leptin, endothelin, and thromboxane A2 while increasing nitric oxide and 6-keto prostaglandin F1α (6-keto-PGF1α), inhibiting atherosclerosis. Yerba maté's high polyphenol content may be involved in these observed effects; the main polyphenol in yerba maté, chlorogenic acid, is thought to modulate activity of glucose-6-phosphatase, involved in glucose metabolism, and to lower risk of cardiovascular disease by reducing low-density lipoprotein (LDL) cholesterol and cholesterol oxidation. Yerba maté's saponin content is also credited, at least in part, with its lipid-lowering effect.

Molecular mechanisms of yerba maté in regulating obesity have been studied in vivo and in vitro. It modulates adipogenesis, the creation of new fat cells, by influencing expression of pre-adipogenic transcription factors and genes that are essential to adipogenesis. It has been found to modulate adipogenesis in a β-catenin-dependent manner, through the wingless-type MMTV integration site protein family (WNT), as well as by enhancing expression of *Gata2*, *Gata3*, and *Klf2*. Given its many bioactive compounds, an effort has been made to determine which has the greatest effect on adipogenesis. Reports indicate that synergy among chlorogenic acid, quercetin, rutin, and other yerba maté compounds may be responsible for its anti-adipogenic effects. Similarly, yerba maté acts on expression of genes related to thermogenesis, inflammation, insulin resistance, and glucose metabolism. It modulates genes that are altered by obesity and restores them to more normal expression levels. Taken together, the data show that it may be useful in obesity, improving lipid parameters and exerting positive effects on insulin resistance.

—Mariann Garner-Wizard

Referenced article can be accessed at http://www.mdpi.com/2072-6643/7/2/730/htm.