P.O. Box 144345 Austin, TX 78714-4345 ▪ 512.926.4900 ▪ Fax: 512.926.2345 ▪ www.herbalgram.org

HerbClip™

File: ■ Anthocyanins
■ Obesity
■ Inflammation

HC 111745-594

Date: June 15, 2018

RE: Role of Anthocyanins in Obesity and Inflammation

Lee YM, Yoon Y, Yoon H, Park HM, Song S, Yeum KJ. Dietary anthocyanins against obesity and inflammation. *Nutrients*. October 1, 2017;9(10):1089. doi: 10.3390/nu9101089.

Obesity, often accompanied by dyslipidemia, hyperglycemia, and/or hypertension, is a major risk factor for cardiovascular (CV) and pulmonary diseases, cancer, and diabetes mellitus (diabetes type 2). Chronic low-grade inflammation both promotes and results from obesity, its progression, and related diseases. Inflammation, the body's first-line defense against harmful stimuli, reacts to excessive nutrients much as it reacts to a wound. Cytokines and chemokines are dispatched to the damaged area and, if repeat or prolonged harmful stimulus occurs, the immune system will also recruit antigen-presenting cells and B- and T-lymphocytes to the site of injury. Such chronic adaptive immunity may increase risks of obesity-related illness. Proinflammatory markers are significantly higher in obese patients than in healthy individuals. One possible underlying mechanism is that toll-like receptors (TLRs), especially TLR4, connect external stimuli, including overfeeding, to transcription factors like nuclear factor-κB, activated protein-1, and interferon regulatory factor 3. These inflammation-associated transcription factors enter cell nuclei and bind to target genes. Preventing or ameliorating chronic proinflammatory or meta-inflammatory conditions is a novel pathway to combat obesity. Obesity-related mortality and morbidity are rising worldwide. Better options are needed.

Several drugs for obesity were removed from the market after causing severe adverse events. Consuming plant compounds, like phenolics, is associated with lower risks of obesity and associated diseases, with low toxicity. Anthocyanins, a large class of flavonoids, occur abundantly in flowers, fruits, seeds, and leaves. The primary structural unit of anthocyanin is 2-phenylchromenylium; it can be further classified into six major anthocyanins—cyanidin, delphinidin, malvidin, pelargonidin, peonidin, and petunidin—with varying flavylium B-rings and in some cases sugars (such as galactose, glucose, and arabinose, etc.) on a basic 2-phenylchromenylium structure. Anthocyanins' antimicrobial, antioxidative, anti-inflammatory, and antimutagenic effects have been studied in relation to metabolic diseases, cancers, eye diseases, and CV diseases. They have been assessed as regulators of obesity and inflammation in cellular, animal, and human models. Some in vitro and in vivo models and their strengths and limitations are described by the authors, with in vitro assays using mouse or human stem cells. In vivo, rats or mice are favored, divided into those that are genetically obese because of a

recessive mutation involving leptin receptors and those that become obese through overeating. Still another model uses rats selectively bred to become obese without high-energy feeding, but there is no discussion of its comparability to humans. In both cell- and animal-based research, use of differing methods helps compensate for the limitations of any single method; still, for reliable knowledge about effects in humans, human subjects must be studied in randomized controlled trials (RCTs).

In vitro, in vivo, and human studies report anthocyanins effective against oxidative stress and inflammation. Overall, mixtures of anthocyanins found in foods are reported more effective than single compounds. Without discussing their search strategy, the authors discuss results of 14 cell-line and animal studies that used dietary anthocyanins with well-characterized bioactive compounds. Among them, a purple sweet potato (*Ipomoea batatas*, Convolvulaceae) extract had antilipogenic and anti-inflammatory effects in mouse adipocytes. Red cabbage (*Brassica oleracea* var. *capitata*, Brassicaceae) microgreens reduced weight gain and low-density lipoprotein (LDL), triacylglycerol, and cholesterol levels in high-energy-fed mice. Blueberry (*Vaccinium* spp., Ericaceae) fruits and juice, probably the most-studied anthocyanin-rich foods, have been reported to reduce weight, blood glucose, liver lipid levels, and inflammatory markers, and to improve insulin resistance. Similar and/or complementary results were found for white mulberry (*Morus alba*, Moraceae) juice, black currant (*Ribes nigrum*, Grossulariaceae), "cherry" (unspecified), tart cherry (*Prunus cerasus*, Rosaceae), black elderberry (*Sambucus nigra*, Viburnaceae), black soy (*Glycine max*, Fabaceae) bean, freeze-dried jaboticaba (*Plinia cauliflora*, Myrtaceae) peel, and chokeberry (*Aronia* spp., Rosaceae). Of three human studies, one RCT used a soy extract with a fully-characterized anthocyanin dose. Compared to the placebo group, subjects in the soy group at study's end had less abdominal fat and lower cholesterol, triacylglycerol, LDL, and inflammatory markers. In two trials of "red orange" (blood orange, sweet orange; *Citrus sinensis*, Rutaceae) juice that was not fully characterized, metabolic and inflammatory markers were reduced.

Anthocyanins have poor bioavailability, and it is increasingly understood that it is their metabolites, created during digestion by gut microbiota, that impact cells, tissues, and signaling systems. Novel delivery systems such as nanoparticles, encapsulation, liposomes, gel emulsions, and alginate (from brown algae [class Phaeophyceae])-chitosan (from shellfish genera) microencapsulation may all increase bioavailability of anthocyanins.

Obesity was once seen as simply the result of excess nutrient intake and insufficient expenditure. Awareness of chronic inflammation's role in its progression and the potential of anthocyanins and other plant phenolics to halt and reverse weight gain not only offers a novel pathway to better health, but may decrease the psychological burdens of obesity. Although not mentioned by these authors, depression and anxiety are deeply linked to obesity in many reports. Tart cherry juice, for example, may exert antidepressant and anxiolytic effects, in part by inhibiting monoamine oxidase A and tyrosinase. This topic should be more deeply explored.

The study was supported by the Rural Development Administration, Republic of Korea.

—Mariann Garner-Wizard

Referenced article can be accessed at http://www.mdpi.com/2072-6643/9/10/1089.