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File: ■ Hibiscus (*Hibiscus sabdariffa*, Malvaceae)
■ Phytochemistry
■ Pharmacology

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RE: Hibiscus Extracts Contain a Wide Range of Bioactive Compounds and Provide a Myriad of Potential Health Benefits

Da-Costa-Rocha I, Bonnlaender B, Sievers H, Pischel I, Heinrich M. *Hibiscus sabdariffa* L. – a phytochemical and pharmacological review. *Food Chem*. December 15, 2014;165:424-443.

Hibiscus (*Hibiscus sabdariffa*, Malvaceae) is a shrub that grows up to eight feet tall and has showy flowers and large edible calyces. Flowers, leaves, and seeds of this tropical or subtropical plant have been used in traditional medicine and as a tea, food source, and flavoring. Hibiscus is thought to have been in cultivation for approximately 6000 years. Its native distribution is uncertain because it has been cultivated in so many regions of the world for such an extensive period of time. Some sources suggest that hibiscus is native to western Sudan. Hibiscus has two main cultivated varieties; *H. sabdariffa* var. *altissima* is primarily used as a source of fiber, while *H. sabdariffa* var. *sabdariffa* is used for human consumption and, occasionally, as a source of fiber.

Hibiscus calyces have been used traditionally for tea, fermented drinks, and desserts. The leaves and shoots are eaten raw or dried, while seeds are ground into meals, roasted and eaten, or used as a coffee (*Coffea* spp., Rubiaceae) substitute. The leaves and calyces are also used in traditional medicine in many countries as diuretics and for sore throats, hypertension, liver disorders, and cardiac disease.

Several countries grow and export hibiscus, and the quality of the plant material is dependent on the country of origin. The highest quality hibiscus material is grown in Thailand and Sudan. China is the dominant supplier of hibiscus to the United States. Currently, only a few countries provide Fair Trade, organic hibiscus, e.g., Egypt and Burkina Faso.

The calyces, leaves, and seeds of hibiscus are rich in vitamins and minerals. Calyces contain vitamin C, β-carotene, calcium, and iron. The leaves also contain high levels of iron and β-carotene and, in addition, thiamine, riboflavin, and ascorbic acid. Hibiscus seeds are rich in fat and protein and also in numerous minerals, including potassium, calcium, and magnesium.

Hibiscus calyces contain a large number of bioactive compounds that include organic acids, anthocyanins, polysaccharides, and flavonoids. The concentration of these compounds varies with tissue, genetic origin of the plant material, and growing, harvesting, and post-harvesting conditions. The main organic acids in hibiscus tissues are citric acid, hibiscus acid, malic acid, tartaric acid, and hydroxycitric acid. Hydroxycitric acid and hibiscus acid are the principle organic acids found in calyces and leaves. The major anthocyanins present in leaves and calyces are delphinidin-3-*O*-sambubioside and cyanidin-3-*O*-sambubioside. Cyanidin-3-*O*-glucoside also occurs in high concentrations within the leaves and calyces. Hibiscus tissues contain a wide range of flavonoids and their derivatives, primarily as flavonols and flavanols in simple or polymerized form. The authors list 33 separate flavonoids and phenolic acids identified in various studies. Seeds have high concentrations of ergosterol. Flowers and calyces contain high concentrations of protocatechuic acid, hibiscitrin, caffeic acid, and gallocatechin gallate. Leaves are particularly rich in ellagic acid and catechins. The mucilage content of calyces and flowers can be up to 28% of the dry weight with anhydrouronic acid being the most abundant component (up to 80%) of this fraction. There are also a wide range of volatile compounds identified within the seeds and calyces. As many as 37 different volatile compounds, including aldehydes, alcohols, ketones, and terpenes, have been identified from calyces.

Extracts of hibiscus tissues have been shown to exhibit antibacterial, anti-inflammatory, and antioxidant activity. Much of their medicinal value is likely related to these characteristics. Both calyx and seed extracts have exhibited antibacterial properties and have potential in both cavity prevention and decreasing food spoilage. In addition, one clinical trial has found that extracts of hibiscus calyx reduced the levels of inflammatory biomarkers in healthy individuals.

Hibiscus's antioxidant properties are probably the best characterized, and many of the positive effects seen in vitro and in vivo are attributed to these properties. Hibiscus extracts have the ability to scavenge reactive oxygen species and free radicals, provide protection against oxidative damage, and increase the activity of superoxide dismutase. Hibiscus extracts have shown protective properties for both liver and kidney tissue in animal and human systems. In one study in rats, oral administration of hibiscus extracts resulted in an increase in oxalate excretion in the urine and decrease in calcium oxalate crystal formation within the kidneys, potentially decreasing the formation of kidney stones. Several studies have found that hibiscus's antioxidant properties may be beneficial in preventing and inhibiting the progression of cancer. In several lines of human cancer cells (prostate, gastric, and leukemia), hibiscus extracts have shown the ability to inhibit cancer cell survival, provide protection against *tert*-butylhydroperoxide-induced cytotoxicity and genotoxicity, and increase apoptosis.

There is compelling evidence that hibiscus extracts decrease the risk factors associated with cardiovascular disease and metabolic syndrome (a number of conditions that increase the risk for coronary artery disease, stroke, and type 2 diabetes). This may be the result of hibiscus's effect on lipid metabolism and hypertension. Several animal studies have shown that leaf and calyx extracts have the ability to lower blood pressure and plasma levels of low-density lipoproteins, triglycerides, and total cholesterol. In addition, studies in rats and in humans have found an increase in plasma levels of high-density lipoproteins after oral administration of hibiscus extract. The effects of hibiscus on blood lipids and hypertension seem to be dose and duration dependent. Higher

doses over longer periods of time appear to be the most effective.

Some evidence suggests that hibiscus extracts can also help increase weight loss which, in turn, positively affects other diseases related to obesity, i.e., diabetes, hypertension, metabolic syndrome, and cardiovascular disease. There is also evidence that hibiscus tea consumption may be particularly beneficial in patients with type 2 diabetes, with improvements seen in lipid profile and hypertension when hibiscus tea is consumed.

Hibiscus has been used as an anti-anemic because leaves and calyces contain high concentrations of iron, and also because the low pH of the extracts results in increased absorption of minerals, i.e., iron, magnesium, and calcium.

Based on its centuries-long history of use in many countries and at large scale, hibiscus, particularly hibiscus tea, is generally considered safe for consumption. Adverse side effects, if any, are mild and transient. No cases of interaction with prescription drugs have been reported.

The two biggest limitations in the understanding of the positive health effects of hibiscus are the small number of rigorous, clinical trials and a lack of characterization of phytochemicals present in the extracts tested. Many of the studies cited in this review were performed in vitro, within animal systems, or, if in human subjects, were conducted with very small sample sizes and, occasionally, without blinding or control groups. The variability in phytochemical composition of hibiscus extracts and the lack of phytochemical characterization make it difficult to compare such studies, to come to more rigorous conclusions, and to identify the bioactive compounds in hibiscus. The authors suggest that rigorous, clinical trials with adequately characterized preparations would result in a better understanding of hibiscus's health benefits.

–Cheryl McCutchan, PhD

The American Botanical Council has chosen not to include the original article.