



Carotenoids in Mangos

The Big Picture:

A mango's rich, yellow-orange flesh color contributes more than just a beautiful hue to the tropical fruit. In fact, the pigments that make up this colorful fruit – carotenoids – are known for their antioxidant qualities. Antioxidants help to repair damage to the body caused by free radicals, which can contribute to a range of health problems including cancer, diabetes and heart disease, just to name a few.

While mangos are steadily gaining a foothold in the U.S. marketplace, one aspect of marketing that could further drive the fruit's success is promoting its nutrient values. Toward this end, the National Mango Board commissioned a research study to explore the fruit's nutrient content, specifically carotenoids. Five varieties of mangos – Ataulfo, Haden, Kent, Keitt and Tommy Atkins – were examined, with product being sourced from Peru, Ecuador, Brazil and Mexico.

The study by Dr. Penelope Perkins-Veazie of the USDA's Agricultural Research Service in Lane, Okla., reveals that mangos offer a new natural source of beta carotene and vitamin C to consumers. Levels of the nutrients vary based on mango variety.

Overall Findings:

- **All mango varieties exceeded 20% of the recommended daily value of vitamin C (serving size equals one medium mango), qualifying the fruit as an “excellent source” of the vitamin.** Mangos contain an average of 93 micrograms per gram of vitamin C, which is similar to the value of cantaloupe (which contains 98 mcg/g per serving), but less than the well-known vitamin C source of oranges (116 mcg/g per serving). Vitamin C helps to boost the body's immune system and aids in healing. The mango industry can use the “excellent source of vitamin C” designation in its marketing and promotional materials.
- **The beta carotene content of mangos in this study met 33% to 103% of the recommended daily value of pro-vitamin A, making mangos an “excellent source” of vitamin A.** Most fruits that contain beta carotene contain 1 to 3 micrograms per gram of the carotenoid (exceptions include cantaloupe, which contains 20 mcg/g, followed by pumpkin). The mangos' content of beta carotene ranged from 5 mcg (in Tommy Atkins) to as high as 26 mcg (in Ataulfo). Beta carotene is converted in the body to vitamin A, which is needed for eyesight and nerve health.
- **The Mexican-grown Ataulfo variety ranked highest in both vitamin C (ascorbic acid) and beta carotene. In fact, this mango's golden flesh is “exceptional” when it comes to levels of vitamin C.**
 - Ataulfo mangos provide more than 200% of the recommended dietary intake of the immune-boosting vitamin. Ataulfo mangos have more than four times the amount of vitamin C of Haden mangos – the variety ranked second highest with regard to vitamin C.
 - Ataulfo mangos also showed the highest level of beta carotene of the five varieties studied, at 26 mcg.
- **The popular Tommy Atkins variety showed the lowest levels of vitamin C and beta carotene.**
 - Although vitamin C levels were the lowest in Tommy Atkins mangos, this cultivar still qualifies as an “excellent source” of the vitamin.
 - Tommy Atkins mangos were also ranked lowest with regard to beta carotene levels. The Keitt variety showed double the amount of beta carotene of Tommy

Atkins mangos; Ataulfo had more than five times more beta carotene than Tommy Atkins.

- **Mangos contain a variety of phenolics like ellagic acid and gallotannin, and one specific to mangos – mangiferin – that can provide various health benefits.** Phenolics are compounds that serve as the base for antioxidants – nutrients in foods that help to repair the oxidation of “free radical” cells in the body that can cause cancer, heart disease, diabetes and other ailments. Phenolic content in mangos varies by variety. Specific phenolics like mangiferin and ellagic acid possess health properties (anti-inflammatory and anti-cancer qualities) that help to boost the body’s immune system. Gallotannin is associated with providing cardiovascular protection, and also has antioxidant and antibacterial properties.
 - Total phenolic content in mangos ranged from 201 mg/kg in Tommy Atkins fruit (considered to have low to medium levels of phenolics) to 1308 mg/kg in Ataulfo mangos (considered to have medium to high levels of phenolics). As a comparison, cucumbers, on the low end of the scale, have approximately 240 mg/kg total phenolics. Blackberries, on the high end of the scale, have 5000-8000 mg/kg total phenolics.
 - Phenolic content was also shown to vary by country of origin. This variance may be caused by ripeness at harvest or the conditions at each farm (soil, rainfall, sun) or the sun/shade location of fruit on the tree, researchers said.
 - In Tommy Atkins mangos from Brazil, total phenolic content ranged from 195 mg/kg to 281 mg/kg.
 - In Tommy Atkins mangos from Ecuador, total phenolic content ranged from 236 mg/kg to 479 mg/kg.
 - In Tommy Atkins mangos from Peru, the only total phenolic content measured was 306.
 - In Tommy Atkins mangos from Mexico, total phenolic content ranged from 201 to 301.
 - In Ataulfo mangos from Mexico, total phenolic content ranged from 993 to 1308.

Looking ahead:

Further research is necessary to determine what growing and harvesting conditions contribute directly to how phenolics are formed in mangos – from which part of the tree the fruit is grown on to soil conditions, rainfall totals, and sun exposure. However, the fact that the fruit contains these valuable antioxidants, as well as high levels of vitamin C and vitamin A, provides further support for the NMB’s marketing efforts touting the health benefits of mangos. The NMB is already taking advantage of the fact that mangos have earned the distinction of being “an excellent source of vitamin C.” Educating the entire industry on the health benefits of mangos will give consumers even more reason to seek out the tropical fruit.