Anshuman Singh and
Shailendra Rajan*

Eating mangoes: A natural way to heal

There is an overwhelming evidence that the presence of health promoting phytochemicals makes fruits and vegetables an ideal food for lowering the risk of chronic diseases like cancer, cardiovascular problems, diabetes and obesity, and for improving the immune function. The interest in fruits and vegetables as excellent natural source of immunity-boosting bioactive compounds has steadily grown; and the ongoing Covid-19 pandemic has particularly stimulated huge interest in phytochemical rich natural foods. Identification and development of phytochemical-rich mango cultivars and hybrids has received a lot of research and policy attention in India, in line with current global trends. ICAR-Central Institute of Subtropical Horticulture, Lucknow is working in this direction with the overall goal of increasing the supply of bioactive compound rich mango fruits to the emerging health-conscious mango consumers, while also enabling mango growers to reap rich dividends by selling phytochemical-dense mangoes on the market.

MANGO fruit is increasingly being recognized as a cheap, nutrient-dense food with immense health boosting benefits. Mango fruit pulp contains a variety of nutrient and non-nutrient bioactive compounds that have anti-carcinogenic, anti-hyperglycemic, anti-inflammatory, and antioxidant properties. Furthermore, the newly discovered health benefits of mango consumption (anti-wrinkle, anti-allergic, hypocholesterolemic, and immunomodulatory) are piquing interest in mango as a super fruit for improving human health and wellbeing.

Nutraceutical compounds in mango

Mango fruit is a rich source of health protecting vitamins (A and C), minerals (potassium, phosphorus and calcium) and sugars (glucose, fructose and sucrose). Ripe fruits are particularly rich in vitamin A, and mango consumption can greatly supplement the retinol equivalent requirements in humans. Mango fruit also has a moderate energy value, and can thus supplement the daily energy needs to a considerable extent. Though rich in sugars, mango consumption in moderate amounts seems to be safe even for diabetics. The polyphenols (e.g. mangiferin and lupeol) present in mango pulp show excellent anti-glycemic properties. Some clinical studies have also shown a lower glycemic index of mango: moderate amounts of mango consumption do not cause a post-meal increase in blood sugar (hyperglycemia) in both normal and diabetic individuals. The growing interest in mango as a functional food is mainly attributed to the presence of a wide range of carotenoids, flavonoids and polyphenols.

Carotenoids

Carotenoids, the pigments that impart a bright yellow color to mango pulp, exhibit strong free radical scavenging (antioxidant) effects, and are thus linked to reduced risk of chronic health problems like cancer, diabetes and heart diseases. β-carotene (pro-vitamin A) is the most abundant carotenoid in mango pulp; other lesser-known carotenoids include neo-b-carotene, auroxanthin, luteoxanthin, violaxanthin and zeaxanthin. A medium-sized ripe mango can enrich the diet with pro-vitamin A. In many countries, where dietary vitamin A needs are often met by artificial substitutes harmful to health; regular mango consumption can greatly meet daily vitamin A needs and eating the fruit regularly maintains eye health. Unlike other fruits like grapes in which carotenoid content drops after veraison, ripe mangoes continue to maintain carotenoid levels, making them an excellent material for developing β-carotene fortified products like wine.

Ascorbic acid

Ascorbic acid (vitamin C) acts as a strong antioxidant, offering protection against oxidative stress-induced health ailments. Further, it helps prevent scurvy, boosts the immune system and aids in healing. Mango fruits are an excellent source of ascorbic acid, and their vitamin C is comparable with citrus fruits and melons. Indian mango cultivars 'Langra' and 'Mallika' are quite rich in vitamin C (~50 mg/100 g of pulp).

Mangiferin

Mango is amongst a few plants that are abundant in mangiferin, a xanthone with remarkable health boosting properties. Mangiferin displays strong antioxidant, anti-glycemic, anti-cancer, anti-microbial and anti-inflammatory effects, to name a few. Being a xanthone, the antioxidant capacity of mangiferin may even be greater than super oxidants (vitamin C and vitamin E). It controls

the blood glucose level by inhibiting glucose absorption from the intestine: defying the popular belief that mango consumption is not good for diabetic patients. Thanks to its antioxidant, anti-inflammatory and gene modulatory properties, mangiferin has gained wide attention as a potential therapeutic for cancer treatment. Recently, mangiferin was found to inhibit the growth of Covid-19 virus (SARS-CoV-2) in molecular docking studies and thus could be a safe therapeutic alternative to chemical inhibitors.

Lupeol

Chemically a triterpene, lupeol is found in high amounts in mango pulp. It shows a range of pharmacological properties against acute or chronic health problems like arthritis, cancer, cardiovascular ailments, diabetes and microbial infections, and is known to accelerate wound healing. Lupeol efficiently alleviates arthritis-related symptoms like inflammation, swelling and pain. Thanks to their strong anti-mutagenic effects, lupeol and its derivatives are considered as excellent starting materials for developing anti-cancerous drugs. Noticeably, while killing cancerous cells, lupeol does not have any harmful effects on normal human cells. Like mangiferin, lupeol also suppresses carbohydrate absorption in the intestine and inhibits the activity of the enzyme α-amylase, thereby lowering the risk of diabetes.

Flavonoids

Flavonoids, the most abundant polyphenols in human diet, are grouped into several classes, like flavones, flavonols and anthocyanins. Besides free radical scavenging properties, flavonoids also exhibit anti-microbial, anti-inflammatory and anti-allergic effects. Catechin, epicatechin, myricetin, kaempferol, rutin and quercetin are the major flavonoids found in mango pulp. Catechin has strong antioxidant, anti-carcinogenic and anti-ageing properties. Myricetin is known for its iron-chelating, antioxidant and anti-inflammatory properties, and is increasingly being seen as a novel therapeutic agent for alleviating iron deficiency-related health problems like anemia. It is worth mentioning that several mango cultivars contain 3-4 times more myricetin than quercetin, another flavonoid valued for its highly beneficial effects in osteoporosis, lung cancer and cardiovascular problems. Hesperidin, a rare flavonone found in some mango cultivars (e.g. Alphonso), shows anti-carcinogenic properties.

Phenolic acids

Mango fruit pulp contains a range of phenolic acids, valued for their functional and nutraceutical properties. Ellagic acid, one of the main phenolic acids found in mango, is quite effective in overcoming obesity and obesity-related health problems like atherosclerosis, type-2 diabetes and non-alcoholic fatty liver disease. It also shows strong antioxidant, anti-carcinogenic, anti-mutagenic and anti-viral effects. The waste generated during mango pulp processing offers a novel source for extracting ellagic acid. Ferulic acid, another prominent phenolic acid in mango pulp, is known for its strong anti-ageing and skin rejuvenation effects. Salicylic acid, known for its skin-caring and anti-acne effects and linked to the reduced risk of colon cancer, was recently identified in the pulp and peel of some mango cultivars. p-Coumaric acid and syringic acid are other lesser-known phenolic acids found in mango pulp. It is believed that yet-to-be-discovered phenolic acids might account for a range of medicinal benefits associated with mango consumption. Further, it is worth mentioning that the aforementioned phenolic acids are often present only in a selected number of mango cultivars; implying the need for tapping the huge genetic wealth of mangos for identifying these and potentially novel phenolic acids for commercial applications.

Harnessing Indian mangoes for nutraceuticals

In India, bioactive compound profiling in mango fruit pulp and other economically significant parts is a relatively new field of study. ICAR-CISH, Lucknow, has recently begun studies to understand the diversity of bioactive compounds in mango pulp of commercial Indian cultivars and newly developed mango hybrids, given the importance of mango in India's horticulture and health sectors. The overall goal of this research is to promote Indian mango cultivars as affordable nutraceutical-rich fruits in export markets while also ensuring better profit margins to the mango growers. Mangiferin and lupeol, two major bioactive compounds of interest in mango pulp, have been found to be particularly abundant in Indian mangoes, according to recent research. Fruit pulp of 'Dashehari' mango is exceptionally rich in lupeol. Mangiferin and lupeol are abundant in the fruit pulp of the newly developed mango hybrids 'Ambika' and 'Arunika,' respectively. Micronutrients are abundant in the fruit pulp of North Indian mango cultivars 'Bombay Green' and 'Dashehari,' as well as other popular cultivars such as 'Langra' and 'Chausa'.

SUMMARY

The bioactive compound profile of fresh fruits, including mango, is influenced by a number of factors, including genotype (cultivar), crop management practices, maturity stage, transport and storage conditions, pre-harvest sprays, and so on. Although it may not be possible to screen all genotypes/accessions, the bioactive compound profiles of as many commercially grown, lesser known but potential farmers' varieties, exotic accessions, and promising hybrids as possible must be evaluated so that those with exceptionally high levels of polyphenols, flavonoids, and phenolic acids can be vigorously promoted for export, and are further used in genetic improvement programs. Furthermore, growers must pay close attention to the best crop management, harvesting, and storage practices developed for mango in order to ensure phytochemical-dense and high-quality fruits.

For further interaction, please write to:
Shailendra Rajan (Director), ICAR-Central Institute for Subtropical Horticulture, Lucknow, Uttar Pradesh 226 101. *Corresponding author *e-mail:* srajanlko@gmail.com