Review

The boon of nature – citrus: an overview

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ABSTRACT

Citrus is the most common cultivated fruit in the world as well as in India. Citrus fruits are not only refreshing and delicious but are also very rich in vitamin C. Apart from this, citrus fruits are good source of minerals like calcium, phosphorous and iron. Citrus fruits are taken fresh as well as in processed form. A wide range of bioactive substances have already been identified in foods and drinks. Lime has different medicinal properties like anti-bacterial, anti-cancer, anti-diabetic, anti-fungal, anti-hypertensive, anti-inflammation, anti-lipidemia and anti-oxidant properties. Its secondary metabolites are alkaloids, carotenoids, coumarins, essential oils, flavonoids, phenolic acids and triterpenoids. It is used against breast cancer, colon cancer, pancreatic cancer and lymphoma. Sweet orange contains important phytochemicals like limonoids, synephrine, hesperidin, flavonoid, polyphenols, pectin and sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium. Its sugars, acids, carotenoids, polyphenols, limonoids and vitamins determine the flavour of the fruit. In the present review, brief description of different species and their nutritive and medicinal values have been discussed to provide collective information about citrus.

Keywords: Citrus; nutritional properties; medicinal properties; species

INTRODUCTION

Citrus is one of the most popular fruits in the world with highest acreage in the tropical and sub-tropical regions of the world. In India, citrus occupies third position after banana and mango (Kedar 2013). Citrus fruits are not only refreshing and delicious but are also very rich in vitamin C and contain 25-60 mg of vitamin C per 100 g of juice. The fruits provide about 51 per cent of vitamin C (García-Closas et al 2004).

In the world, citrus is dominated by sweet orange with a 64 per cent contribution followed by mandarins with 20 per cent, limes and lemons 10 per cent and rest of the 6 per cent contributed by grapefruit and other citrus fruits (De 2017). About two-third of the total production of citrus is used for fresh consumption and the remaining one-third in the processing industry (Cuenca et al 2018). Citrus fruits are mainly consumed in developed countries; consumption of fresh mandarin and citrus juice is increasing worldwide mainly due the improvements made in quality and the competitiveness of prices associated with technological progress.

The species cultivated in India are *Citrus aurantifolia, C aurantium, C deliciosa, C grandis, C jambhiri, C karna, C latifolia, C limetta, C limettioides, C limon, C limonia, C macroptera, C maderaspatana, C madurensis, C medica, Cmegaloxycarpa, C nobilis, C paradisi, C paratangerina, C pennivesiculata, C reticulata*. The genus belongs to the large family Rutaceae.

Lime

Lime comprises both acidic limes and sweet limes. Its origin is the tropical area of the Malay Archipelago (Yelenosky 1985). *C aurantifolia* is a perennial evergreen tree that can grow to a height of 3-5 m. Its stem is irregular, slender and branched and

possesses short and stiff sharp spines. Its leaves are alternate, elliptical to oval, 4.5-6.5 cm long and 2.5-4.5 cm wide with small rounded teeth around the edge. Flowers are short and axillary racemes; petals are 5, oblong and 10-12 mm long; fruits are green, round, 3-5 cm in diameter and yellow in colour.

Medicinal properties of lime and nutritive value: Lota et al (2002) found at least 62 volatile compounds in the fruit peel and 59 in the leaf. In the fruit peel oils, limonene was the major volatile component followed by terpinene, pinene and sabinene. In leaf oils, limonene, pinene and sabinene were the major components followed by citronellal, geranial and linalool.

Hydrodistilled essential oil of *C aurantifolia* shows presence of limonene (58.4%), ß-pinene (15.4%), ß-terpinene (8.5%) and citral (4.4%) as the major constituents (González-Mas et al 2019). Okwu and Emenike (2007) also reported that citrus fruits contain crude protein (18%), crude fiber (8%), carbohydrate (78%), moisture (6%), crude lipid (1%), ash (8%) and food energy (363 g/calories) in fresh fruits. The most important minerals detected in the fruit include calcium (3%), phosphorus (0.4%), potassium (1%), magnesium (0.6%) and sodium (0.4%).

***Colon cancer*:** *C aurantifolia* consists of at least 22 volatile compounds and its major compounds are limonene (30%) and di-hydrocarvone (31%). Patil et al (2009) reported that 100 µg/ml of *C aurantifolia* extract can inhibit the growth of colon SW 480 cancer cells. Patil et al (2010) reported that the new three coumarins from *C aurantifolia* peel were 5 geranyloxy 7 methoxycoumarin, limettin and isopimpinellin.

***Pancreatic cancer*:** Patil et al (2009) reported that the active components of *C aurantifolia* juice are rutin, neo-hesperidin, hesperidin, and hesperetin. The gross morphology of *C aurantifolia* found limonoid substances such as limonexic acid, isolimonexic acid and limonin. Moreover, 100 µg/ml of *C aurantifolia* juice extract can stop 73-89 per cent of pancreatic Panc 28 cancer cells growth after 96 h of exposure. The result of apoptosis was confirmed by the expression of Bax, Bcl 2, casapase 3 and p53. Patil et al (2010) reported the five active components of *C aurantifolia* seeds viz limonin, limonexic acid, isolimonexic acid, β-sitosterol glucoside and limonin glucoside.

***Breast cancer*:** Gharagozloo et al (2002) reported that 125-500 µg/ml of *C aurantifolia* fruit juice extract inhibits the growth of breast MDA MB 453 cancer cells after 24 h of exposure. Adina et al (2014) observed that 6 and 15 µg/ml of *C aurantifolia* peel inhibits the growth of breast MCF 7 cancer cells at G1 and G2/M phase respectively after the exposure of 48 h.

***Lymphoma*:** Castillo-Herrera et al (2015) reported that the limonin extract of *C aurantifolia* seeds from Mexico inhibited the growth of L5178Y lymphoma cells with IC50 of 8.5-9.0 µg/ml.

Sweet lime

Sweet lime is a large and spreading tree with medium size leaves which are pale green in colour with prominent oil glands. The flowers are large, pure white, fragrant and solitary or in short cymes, borne axillary on current flush of growth. The flowers are perfect, with 5 petals and sepals. Poly-embryonic character of sweet lime suggests that it is probably hybrid that is nearly sterile. Fruits are so important that they have received a special name – a hesperidium (Ortiz 2002).

Nutritive value of sweet lime: It has high vitamin C and folic acid content that ensure strong immunity, glowing skin health and support to bones and joints. Citrus also contains other extremely beneficial compounds including chlorophyll, carotenoids, phenolics, flavonoids and limonoids.

According to the Nutritive Value of Indian Foods published by the National Institute of Nutrition, 100 g of sweet lime has moisture 88.4 per cent, protein 0.8 g, fat 0.3 g, minerals 0.7 g, fibres 0.5 g, carbohydrates 9.3 g, calcium 40 mg, phosphorus 30 mg, potassium 490 mg, iron 0.7 mg and vitamin C 50 mg (Kumar et al 2017).

Sweet lime is used for many purposes for example it is suitable for eating and contains peel oil and juice oil which are volatile in nature. It contains high amount of ascorbic acid (Sandhu and Minhas 2006) and its juice is used as a sweet drink in summer. Limonene (60.17%) is the most abundant terpene followed by gamma-terpinene (11.80%), terpinolene (2.96%), beta-pinene (2.08%), linalool (1.85%), p-cymene (1.38%), geranial (1.33%) and alpha-terpineol (1.28%). The remaining terpenes amounted to <1 per cent found in the peel of sweet lime (Abdul et al 1992).

Medicinal properties: Sweet lime has high content of flavonoids that stimulate the digestive system by increasing secretion of digestive juices, acid and bile.

The acid in sweet lime flushes out the toxins from bowl tracts; the fruit contains dietary fibre which enables the roughage to act as purgative treatment for those suffering from constipation. The flavonoids present in sweet lime such as limomin and glucoside have anticarcinogenic and antioxidants detoxifying and antibiotic properties which are very effective in healing oral and peptic ulcers. Limonoids present in sweet lime help in fighting different types of cancer. Being rich in vitamin C, it reduces the symptoms of osteoarthritis and rheumatoid arthritis.

Lemon

Lemon (*Citrus* × *limon*) is a hybrid of the genus *Citrus*. It has thorny branches, white flowers with purple edges, elliptical-acuminate and shiny leaves. The acidic juicy fruit is oval shaped and has an aromatic rind that is yellow when ripe. Lemon is an important medicinal plant of the Rutaceae family that originated in tropical and sub-tropical southeast Asia (Arias and Ramón-Laca 2005).

Nutritive properties: The fruit juice contains fruit acids, mainly citric acid (8%) and sugars. Lemon peel consists of two layers: the outer layer (pericarp, zest) contains essential oil (6%) which is composed of citral (5%) plus traces of citronellal and limonene (90%), alpha terpineol, geranyl acetate and linalyl. The inner layer (mesocarp), contains no essential oil but has a variety of coumarin derivatives and bitter flavone glycosides (Imbesi and De Pasquale 2002).

Traditional properties: The intake of lemon juice with honey helps to reduce the weight. Lemon juice has a wide property of skin benefits. It is rich in vitamin C and helps in lightening the skin. Lemon juice when used by people suffered with urinary tract infection problem, lowers the level of uric acid. Mixture of lemon juice with olive oil has been found effective to cure gall bladder stones and kidney stones. Lemon juice is a liver stimulant, controls nausea and relieves heart burns and irritable bowel syndrome. (Imbesi De Pasquale 2002).

Medicinal properties: Leave caffeinated drinks behind and stimulate digestive track by the using fresh lemon juice and hot water. Citrate levels in the urine can be raised by drinking one half-cup of lemon juice every day. It can protect against calcium stones in the kidney (Ehler 2011). Honey mixed with lemon juice can help alleviate and discomfort to treat nasty sore throat. In ancient times, the old notion was that the lemonade diet/Master Cleanse was the only way to lose weight with the help of lemons. New studies have shown the ways how lemon juice supports weight loss. Lemon juice contains pectin, a soluble fibre, which helps in weight loss. Lemon juice show anti-inflammatory and anaesthetic effects (Al-Snafi 2016).

Sweet orange

Citrus sinensis (L) Osbeck or sweet orange originated from southeast Asia but is consumed all over the world as an excellent source of vitamin C; a powerful natural antioxidant that builds the body immune system Morton (2000). It is a small evergreen tree 7.5 m high and, in some cases, up to 15 m. Orange produces leathery and evergreen leaves of different shapes, ranging from elliptical, oblong to oval, 6.5-15 cm long and 2.5-9.5 cm wide. It bears fragrant white flowers either singly or in whorls with 5 petals and 20-25 yellow stamens. The small, white or purple scented hermaphroditic flowers produce nectar for pollination by insects. The fruit may be globose to oval (6.5 to 9.5 cm wide) and ripens to orange or yellow. Anatomically, the fruit consists of two distinct regions, the pericarp, also called the peel, skin or rind and the endocarp or pulp with juice sac glands (Orwa et al 2009, Han 1998).

Medicinal properties: Important phytochemicals like limonoids, synephrine, hesperidin flavonoid, polyphenols, pectin and sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium are also present in sweet orange. These biologically active compounds prevent arteriosclerosis, cancer, kidney stones and stomach ulcers and reduce cholesterol level and high blood pressure which promote human health (Etebu and Nwauzoma 2014). The human diet contains important micronutrients namely vitamins C and E, carotenoids and flavonoids essential for maintenance of human health. Multiple dietary sources of these compounds are present in all plant material (Di Majo et al 2005).

Nutritive properties: The nutritional importance of foods is due to the presence of these functional food ingredients and antioxidant nutraceuticals or phytochemicals. Phytochemicals are present in edible fruits; when eaten potentially, these modulate human metabolism in a favourable manner, thereby, prevent chronic and degenerative diseases (Tripoli et al 2007).

***Antioxidant*:** The biological activity and the health effects of citrus flavonoids as antioxidants have been reported by Tripoli et al (2007). These groups of

pigments as found in plants and together with anthocyanin play a role in flower and fruit colouration. Studies by Darmon et al (1990) indicate that flavonoids are excellent radical-scavengers of the hydroxyl radical.

The oranges are excellent source of vitamin C, contain powerful natural antioxidant, folate, dietary fibre and other bioactive components, like carotenoids and flavonoids that prevent cancer and degenerative diseases (Ejaz et al 2006). Consumption of foods, rich in vitamin C, improves body immunity against infectious agents and scavenging harmful, pro-inflammatory free radicals from the blood. Sweet orange contains a variety of phytochemicals like hesperetin and narigenin. Naringenin has a bioactive effect on human health as antioxidant, free radical scavenger, anti-inflammatory and immune system modulator.

***Anti-inflammation*:** Citrus flavonoids contain compounds with anti-inflammatory activity due to the presence of regulatory enzymes (protein kinase C, phosphodiesterase, phospholipase, lipoxygenase and cyclooxygenase) that control the formation of the biological mediators, responsible for the activation of endothelial cells and specialized cells involved in inflammation.

The citrus flavonoids are able to inhibit the kinases and phosphodiesterases essential for cellular signal transduction and activation. They also affect the activation of a number of cells involved in the immune response, including T and B lymphocytes (Manthey et al 2001). The flavonoids also prevent atherosclerosis thus inhibit the formation of atheroma (Hertog et al 1993). Tripoli et al (2007) reported that hesperidin obtained from citrus cultures may have a potential therapeutical use as a mild anti-inflammatory agent.

***Anti-cancer and anti-arteriosclerosis*:** Findings of Elangovan et al (1994) revealed that the flavonoids help to prevent the cancer through selective cytotoxicity, anti-proliferative actions and apoptosis. Flavonoids are anti-mutagenic, thus protect the DNA from damage by their ability to absorb ultraviolet light. Flavonoids can also protect the DNA by interacting directly with the tumoral agents as in the induced chromosomal aberrations by bleomycin. Heo et al (1994) and Braddock (1999) reported the inhibitory effect of citrus flavonoids on tumoral development and cell proliferation by rat malignant cells, in cardiac and hepatic tissue of syngenetic rats. Oranges are also rich in iron, chlorine, manganese, zinc, sodium, phosphorous, iodine, calcium, folic acid, potassium, pectin, beta-carotene and amino acids and fibre. A single orange has about 170 phytonutrients and over 60 flavonoids with anti-tumor, anti-inflammatory, blood clot inhibiting and antioxidant properties. Crowell (1999) reported that all these properties help to promote overall health.

***Anti-obesity*:** Sweet oranges contain low calories and no saturated fats or cholesterol, but are rich in dietary fibre and pectin which are very effective in persons with obesity. Pectin as bulk laxative protects the mucous membrane from exposure to toxic substances as well as by binding to cancer-causing chemicals in the colon.

Sinclair et al (1945) reported that pectin helps to reduce blood cholesterol levels by decreasing its re-absorption in the colon by binding to bile acids in the colon. Orange peels contain the alkaloid synephrine which reduces the production of cholesterol in the liver.

CONCLUSION

Citrus is one of the most popular fruit commodities in the world. Commercially, several species fall under the term citrus, including lemons, limes, mandarins, satsumas, clementines, common mandarins and tangerines, oranges, grapefruits and pummelos. Many citrus fruits, such as oranges, tangerines, grapefruits and clementines, are generally eaten fresh. Citrus species is a category of fruits that contains a variety of bioactive components throughout the plant. Citrus fruits (and their products) are among the most widely eaten fruits in the world and their supply continues to increase.

Vitamin C, pectin, limonene, phenolics, iso-limonene, flavanones and nonanal are the main bioactive components present and they provide a variety of health advantages. Orange and grapefruit juices are also popular breakfast beverages.

More acidic citrus fruits, such as lemons and limes, are generally not eaten on their own. A variety of flavours can be derived from different parts and treatments of citrus fruits.

The implementation of effective and reliable breeding programmes is essential for coping up with the increasing demands of satisfactory yield and quality of the fruit.

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