



## Dragon Fruit: Cultivation, Nutritional Significance, and Health-Promoting Properties

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Dragon fruit belongs to the cactus family Cactaceae and is classified under the genus *Hylocereus* (Patwary *et al.*, 2013). The fruit has become increasingly popular because of its unique appearance, sweet taste, and excellent nutritional properties (Rao & Sasanka, 2015). Originally native to Mexico and Central America, dragon fruit is now cultivated in many tropical and subtropical countries worldwide including Vietnam, Thailand, China, India, Bangladesh, Israel, and Australia (Mizrahi & Nerd, 1999). The increasing awareness regarding healthy diets and functional foods has contributed significantly to the commercial expansion of dragon fruit cultivation (Parmar *et al.*, 2019). Consumers prefer dragon fruit because it contains low calories, high moisture, dietary fiber, vitamins, antioxidants, and beneficial phytochemicals (Liaotrakoon, 2013). Furthermore, the fruit demonstrates strong economic potential due to its high market demand and profitability for growers (Karunakaran & Arivalagan, 2019).

Dragon fruit (*Hylocereus spp.*), also known as pitaya, is a tropical and subtropical fruit crop that has gained global recognition because of its nutritional richness, medicinal value, attractive appearance, and increasing commercial importance. The fruit is widely cultivated in Southeast Asia, Central America, Australia, and Mediterranean regions due to its adaptability to different climatic conditions (Mizrahi *et al.*, 1997). Dragon fruit is considered a functional food because it contains antioxidants, vitamins, minerals, dietary fibers, and essential fatty acids that contribute significantly to human health (Choo & Yong, 2011). Research studies indicate that the fruit possesses antimicrobial, anti-inflammatory, anti-diabetic, antioxidant, and cardioprotective properties (Patel & Ishnava, 2019). In addition to fresh consumption, dragon fruit is utilized in the preparation of juices, jams, wines, desserts, nutraceuticals, and cosmetic products (Sonawane, 2017). The peel and seeds also contain valuable bioactive compounds and natural pigments suitable for industrial applications (Harivaindaran *et al.*, 2008). This article provides an expanded overview of dragon fruit cultivation practices, botanical characteristics, nutritional composition, medicinal applications, industrial uses, and future research opportunities.

### Botanical Characteristics

Dragon fruit is a perennial climbing cactus with succulent green stems and aerial roots that assist in climbing support structures (Patel & Ishnava, 2019). The stems are triangular or three-winged with wavy margins and may contain small spines depending on the species (Crane & Balerdi, 2005). The plant produces large fragrant white flowers that bloom during the night, which is why dragon fruit is often referred to as the “Queen of the Night” (Merten, 2003). The fruits are oval or oblong with leathery skin covered in scale-like appendages. The pulp may be white, pink, or red and contains numerous edible black seeds rich in essential fatty acids (Ariffin *et al.*, 2009). Three major cultivated species include

*Hylocereus undatus* with white flesh, *Hylocereus costaricensis* with red flesh, and *Hylocereus megalanthus* with yellow skin and white flesh (Hunt, 2006).

### Climate and Cultivation Practices

Dragon fruit grows successfully in dry tropical and subtropical climates with temperatures ranging between 21°C and 29°C (McMahon, 2003). The crop requires moderate rainfall and well-drained sandy loam soils enriched with organic matter (Perween *et al.*, 2018). Although dragon fruit is drought tolerant, proper irrigation management is essential for flower initiation and fruit development (To *et al.*, 2002). Propagation is commonly performed through stem cuttings because vegetative propagation ensures earlier flowering and uniform plant growth (Rao & Sasanka, 2015). Seed propagation is less preferred because it requires a longer juvenile phase before fruit production. Plants propagated from cuttings may start flowering within 15–18 months under suitable environmental conditions (Mallik *et al.*, 2018). Commercial plantations generally use concrete pillars or trellis systems to support climbing stems and maximize productivity (Rahim *et al.*, 2009). Flowering and fruit setting are significantly influenced by environmental factors such as temperature, light intensity, humidity, and photoperiod (Yen & Chang, 1997). Manual pollination is sometimes necessary because flowers bloom at night and natural pollinators may be absent in certain cultivation regions (Weiss *et al.*, 1994).

### Nutritional Composition

Dragon fruit is widely recognized for its exceptional nutritional composition. The fruit contains carbohydrates, proteins, vitamins, minerals, dietary fibers, and bioactive compounds that contribute to overall health and well-being (TFIDRA, 2005). Fresh dragon fruit pulp contains vitamin C, calcium, phosphorus, iron, and several B-complex vitamins including vitamin B1, B2, and B3 (Thokchom *et al.*, 2019). The fruit is rich in antioxidant compounds such as betalains, flavonoids, carotenoids, and hydroxycinnamates, which help protect cells against oxidative damage (Rodriguez *et al.*, 2015). Red-fleshed varieties contain higher concentrations of betalains and polyphenols compared to white-fleshed varieties (Senadheera & Abeysinghe, 2015). Dragon fruit seeds contain omega-3 and omega-6 fatty acids that support cardiovascular health and reduce inflammation (Sonawane, 2017). The peel also contains pectin and natural pigments that can be used as food additives, thickening agents, and natural colorants (Nur Izalin *et al.*, 2016).

### Health Benefits

Several scientific investigations have demonstrated the therapeutic and medicinal benefits of dragon fruit. The fruit exhibits antioxidant activity due to the presence of polyphenols, flavonoids, betalains, and vitamin C (Cheah *et al.*, 2016). These compounds help reduce oxidative stress and may lower the risk of chronic diseases such as cancer, diabetes, and cardiovascular disorders (Verma *et al.*, 2017). Dragon fruit promotes digestive health because of its high dietary fiber content and prebiotic oligosaccharides that stimulate the growth of beneficial gut bacteria such as *Lactobacillus* and *Bifidobacterium* species (Wichienchot *et al.*, 2010). The fruit also helps improve bowel movement and nutrient absorption. The iron content of dragon fruit contributes to hemoglobin formation and may help prevent anemia, especially among pregnant women (Nurliyana *et al.*, 2010). Calcium and phosphorus strengthen bones and teeth and support tissue formation (Choo & Yong, 2011). Furthermore, regular consumption of dragon fruit has been associated with reduced cholesterol levels, improved blood glucose regulation, enhanced immunity, and better cardiovascular function (Kumar *et al.*, 2018). Bioactive compounds extracted from dragon fruit peel have demonstrated antimicrobial and antibacterial activities against several pathogens (Nurmahani *et al.*, 2012). These findings indicate the potential of dragon fruit in pharmaceutical and nutraceutical industries.

## Industrial Applications and Economic Importance

Dragon fruit has multiple industrial and commercial applications. The fruit is consumed fresh and processed into juices, jams, jellies, wines, ice creams, yogurts, candies, and bakery products (Minh *et al.*, 2019). In some Asian countries, flower buds and young stems are cooked and consumed as vegetables (Perween *et al.*, 2018). The peel is increasingly utilized as a natural food coloring agent because of its betalain pigments and antioxidant compounds (Harivaindaran *et al.*, 2008). Dragon fruit peel powder is also used in cosmetics, soaps, beverages, and nutraceutical supplements (Moshfeghi *et al.*, 2013). The global market demand for dragon fruit has increased significantly due to rising consumer preference for functional foods and natural antioxidants (Parmar *et al.*, 2019). Consequently, dragon fruit cultivation has become an important income-generating agricultural enterprise in many developing countries.

## Conclusion

Dragon fruit is an economically valuable and nutritionally rich fruit crop with immense potential for agriculture, food industries, pharmaceuticals, and human health promotion. The fruit contains important vitamins, minerals, dietary fibers, antioxidants, and phytochemicals that contribute to disease prevention and overall health. Its adaptability to tropical and subtropical climates, relatively low water requirement, long productive lifespan, and increasing global demand make dragon fruit a promising crop for sustainable agricultural development (Trivellini *et al.*, 2020). Further research should focus on genetic improvement, disease management, post-harvest technology, value addition, and clinical validation of medicinal properties to maximize its commercial and therapeutic potential.

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